A Laboratory Guide in Psychology

BISHWA NATH MUKHERJEE

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A
Laboratory Guide
in
Psychology

Bishwa Nath Mukherjee

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To

Prof. Robert S. Woodworth

Emeritus Professor of Psychology,

COLUMBIA UNIVERSITY, U. S. A.

Foreword

A convenient manual and a laboratory guide is always an asset to any teacher of modern psychology. The subject matter of Psychology is intimately connected with our living, and the operation of many of its principles and theories we can observe quite easily if we are only a little more careful. As a matter of fact, teaching can be successful and effective if such operations are observed by the individuals themselves. For this reason carefully planned practical classes, supplementing the instructions given in lectures, are essential. If the student is able to demonstrate and check for himself some of the laws and principles of Psychology taught in general classes, he grasps the subject matter better, and more thoroughly. In fact one of the ways by which Psychology should be taught interestingly and scientifically is by arranging appropriate practical classes in which students themselves are able to study their sensing, perceiving, learning, memorizing, emotions, incentives, and so on.

Sri Bishwa Nath Mukherjee, M. A., the Research Assistant attached to the Institute of Psychological Research & Service, has done a singular service in this respect. Many manuals and laboratory guides in Psychology published in foreign countries are available. Mr. Mukherjee has not only added an Indian edition to the list, but has organized his manual in a manner which would suit the requirements of advanced students of Psychology working for a University degree. He has covered large number of important experiments in the fields of Sensation, Psycho-physical methods, Attention, Learning and Memory, Fatigue, Re-action time, Emotion and Motivation. One can certainly add to this already long list of experiments given in this manual. But whatever Mr. Mukherjee has presented, he has done clearly and with suitable illustrations. The scoring charts presented should be useful to the students and instructors alike. The appendix giving the names and addresses of different firms dealing with Psychological apparatus should particularly be of interest to those teachers, who are thinking of organising a Psychological Laboratory in their institutions.

I have no doubt that all those interested in Psychology would commend this maiden effort of Sri Bishwa Nath Mukherjee.

Sd/- **Durganand Sinha,**
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Head of the Department
of Applied Psychology

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PREFACE

This laboratory guide has been written with a view to introducing students to certain methods of psychological experimentation. The methods described are simple and suitable to the resources and limitations of the Indian Universities and Colleges. This laboratory guide, meant for the use of Graduate and Honours students in Psychology, aims to help them in conducting a number of standard psychological experiments more or less in the same way in which their training in laboratory experimentation is usually imparted. It furnishes the introduction of each experiment, describes the way in which observations are to be made, gives the statistical formulae necessary to treat the data and finally gives hints as to the questions which might have a bearing on the data and which, therefore, should be discussed.

Throughout the book the aim has been to prepare a self-explanatory manual which would spare the students, instructors and assistants many troubles by providing a ready and handy reference. The different apparatus required in conducting the given experiments are mostly simple and readily available in India. In the appendix of this manual, are given the name and address of different firms dealing with these apparatus. Description of the apparatus accompanied by drawings and in some cases, wiring diagrams, are other features of this laboratory guide which, it is expected, would be of real help to the students in gaining proficiency in handling them.

The author expresses his heart-felt thanks to Mr. Ram Chandra Prasad, Lecturer in Psychology, Patna University and Mr. Gourango Bhattacharya, M. A., who read part of the manuscript. The author has the proud privilege in acknowledging his sincere indebtedness to Prof. Robert S. Woodworth, Emeritus Professor of Psychology, Columbia University for giving permission to quote and reproduce some materials from his monumental volume '*Experimental Psychology*' (1938) and from the '*Archives of Psychology*'. Grateful appreciation is due also to the authors cited and to the copyright owners, particularly Messrs. Henry Holt & Co., N. Y., John Wiley & Sons, Inc. N. Y. and Cambridge University Press, London for giving kind permission to reproduce the necessary materials. The author is no less grateful to Shri Maithili Saran Singh, Managing Partner of Pustak Bhandar who has so kindly agreed to publish this volume. Finally, the author takes this opportunity to express his gratitude to Shri Shyamchandra Prasad Shrivastava who not only took pains in rectifying many inconsistencies and other errors appearing in the manuscript but helped a lot in expediting the publication of this book. Without the help and co-operation of Mr. Farooque, who took lot of troubles in typing out the entire manuscript, this book would not have come out.

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B. N. M.

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General Instructions to the Students

FOR

Reporting Experiments

Reports of Psychological experiments follow more or less the same steps as are involved in designing and carrying out the experiment. The following heads are suggested which should be touched upon while reporting an experiment :—

1. **Problem :**

   State the problem in clear terms.

2. **Introduction :**

   Under the heading 'Introduction', the following should be included :—
   (a) If the problem is connected with terms which are not generally used, it should be defined.
   (b) State in brief if any work related to the problem has been done and state also the results obtained.
   (c) State your problem in terms of testable hypothesis and show how you come upon it.

3. **Information** regarding
   (a) Apparatus and materials
   (b) Subject (s) used.

4. **Experimental Procedure:**
   (a) State the method to be used and present in tabular form the experimental design.
   (b) Describe the experimental procedure in detail.

5. **Results:**

   Summarize your results by means of tables and graphs.

6. **Discussion:**
   (a) Interpret the results and discuss how far your hypothesis is supported by the obtained results.
   (b) State the limitation faced.
   (c) Explain the obtained results.

7. **Summary and Conclusions:**

   Summarise the following:—
   (1) Your problem in terms of hypothesis.
   (2) Experimental method used.
   (3) Results obtained.
   (4) Limitations of the Experiment.
   (5) Conclusions drawn.

EXPERIMENT 1

Mapping out the Touch Spots

INTRODUCTION :

A great number of bulbs and corpuscles are embeded in the skin which form the termini for nerve fibres. These are believed to be the receptor organs or Cutaneous Sensation. Meissner's Corpuscles found on the hairless portions of the skin and Pacinian Corpuscles, large and with well developed Capsule, found in the subcutaneous tissue and the nerve endings at the root of hairs are usually regarded as the receptor organs for touch. When adequate stimulus is applied on these receptors, we get the sensation of touch. The adequate stimulus for the touch sense is simply a contact on the end-organs. If the stimulus is applied with Pressure that bends or stretches the skin, the sensation evoked is called Pressure Sense. These receptors are randomly distributed throughout the body but the tips of fingers are areas which are particularly sensitive to contact or touch.

In the present experiment, we have to map out the touch spots on a portion of palmer forearm and examine their stability.

MATERIALS :

(1) 1 Wooden Skewer in which fastened a boar's bristle on its end at right angles to it.

(2) A 2-cm. Sq. grid stamp with 4 m. m. cross section lines.

(3) Blindfold.

(4) Safety razor.

(5) Stamp Pad.

(6) A towel

PROCEDURE :

(1) The 'S' is seated comfortably on a chair and the volar surface of his Palmer forearm is shaved and stamped with the grid stamp.

(2) His forearm is kept on the towel for comfort and his eyes blindfolded.

(3) The Ulnar and Dorsal sides of the forearm are marked with suitable signs.

(4) The corresponding Square is marked on the note book in which to record the response of 'S'.

(5) The following instruction is given to the 'S':—"*I will touch something after each 'ready' signal on the stamped region of your forearm. When you feel any contact on it, say "Yes", if not, say "No" and if you are in doubt, say "Doubtful"*".

(6) With the bristle as a stimulus, the middle points of each cell of the Square marked on the 'S's forearm, are systematically explored and a 'ready' signal is given before each application. The 'S's report taken in terms of 'yes', 'no' and 'doubtful' is written with appropriate symbol on the corresponding stamp marked on the note book.

(7) Care is taken that the bristle is simply touched on the skin and no pressure is given on it.

(8) The experiment continues till the midpoints of all the cells are systematically explored.

(9) After an hour, the same experiment is conducted on the same stamped area and the responses taken in the same way. This retest is taken to examine the stability of the spots explored.

RESULTS :

The different cells in which 'yes' were reported, are taken as the touch spots and they are shown with dots on a fresh square in the note-book. The retest result is shown in the same way and the spots verified in the retesting are taken as the reliable ones. They should also be shown in another stamp marked on the note-book.

DISCUSSIONS :

The following questions should be answered with reference to the result obtained :

(1) What was the relative frequency of verified touch spots ? How many touch spots were explored per square centimeter **?**

(2) How do you explain the variability of your results ? (See Woodworth Page 457-460 in this connection) Suggest ways in which the technique of the experiment might be improved.

REFERENCES :

(1) Woodworth, R. S.— *Experimental Psychology* (1938) Pp. 454-460.

(2) Boring, E. G. — *Sensation & Perception in the History of Experimental Psychology.* (1942)—Pp. 463-475.

(3) Collins, Mary & Drever, James-*Experimental Psychology* (1948) Chapter III.

EXPERIMENT 2

Mapping out Cold and Warm Spots

INTRODUCTION:

The direct stimulus for Cold and Warmth is not the outside radiant energy known as heat but a change in the temperature of the receptor. Thermometers measure physical temperature in terms of a single series of more or less heat, but to treat the psychological counterpart with it will be erroneous. Thus a given temperature of 45° C. may be cold or indifferent for one, warm or hot for another. The judgement changes from person to person and in the same person from time to time. "Moreover, only a small range of intensities of physical heat—that extending from about—10° to + 70° C.— gives rise to temperature experiences. Temperatures below and above this narrow range usually evoke only pain and those falling within it tend to evoke cold or warmth or nothing at all, accordingly as they affect the temperature of the skin at that moment and the heat flow which normally passes outward from it."†

"Cold spots, normally stimulated by temperatures below 'physiological zero' (the temperature of the skin at the point of indifference) are also stimulated by certain temperatures above it. For example, a cold spot, in a region of the skin whose 'physiological zero' is 33°C., gives no response to temperatures ranging from 34° to 43° C. but to temperatures above about 43°, it responds with a distinct and intense experience of cold. This response is called 'Paradoxical Cold', since it seems paradoxical that a warm object should arouse cold."† VonFrey (1895) reported that with punctiform warmth stimuli (about 45° C.), he would occasionally arouse an experience of cold, not at a cold point but near one. 'Paradoxical cold' as he called this experience was first found by Strümpbell (1881) and was later verified by Goldscheider (1926), Boring (1916), Lehmann (1892) and many others. According to Goldscheider, he, Ponzo (1909) and Rubin (1912) independently reported similar facts for 'Paradoxical Warmth' with temperatures, below 'physiological zero' between about 25° and 31°C. These responses, however, are weaker and much less insistent than the paradoxical responses of the cold spots.

The purpose of the present experiment is to explore the cold and warmth spots on the Volar forearm and it attempts to demonstrate Paradoxical Cold. It also attempts to acquaint the subject with the qualities of experience in their simplest forms.

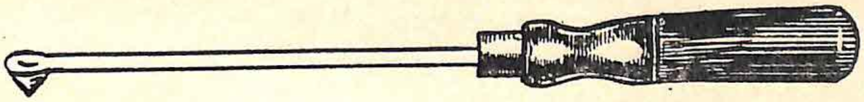

Fig. 1. Metal Cone
(Manufactured by Aero Voice, Patna)

MATERIALS:

- * (1) 4 Metal Cones. (Fig. 1)
- (2) Grid stamp, 2 cm. sq.
- (3) Stamp-Pad.
- (4) 2 Cups.
- (5) Electric Heater.
- (6) Thermometer.
- (7) Drying cloths.
- (8) Safety-razor.

---

* Heat spot tester (Fig. 2) is used when only Warmth spots are to be explored. For this experiment Metal cones or Temperature cylinders will do.

† Quoted from K. M. Dallenbach's 'Somesthesis' in Boring, Langfeld & Weld's *Psychology* (1935). By permission of John Wiley & Sons, Inc. New York.

(9) Towel.
(10) Blindfold.
(11) Ice.
(12) A bottle with cork to keep water at constant temperature.

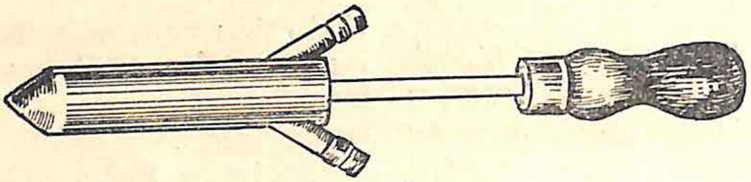

Fig. 2. Heat Spot tester
(Manufactured by Aero Voice, Patna)

PROCEDURE:

Part 1—*Cold Spots.*

(1) 2 cm. Square is stamped on the Volar side of the 'S's arm, after it is shaved and washed.

(2) The corresponding Square is plotted on the note book to record 'S's response symbolically.

(3) The thermometer is adjusted in a stand and a cup is kept below the thermometer on the table to make a bath of desired temperature. Water of 5° centigrade is prepared by pouring ice in the cup and 2 of the metal cones are kept in it.

(4) The temperature of the room is noted if the same experiment is desired to be repeated after some days.

(5) The 'S's hand is comfortably placed on a cotton padding or on a towel and after blindfolding him the following instruction is given:—

> *"I am going to touch your skin with some blunt points. It will not hurt you in any way. Please report when you get any sensation, by saying 'Cold', 'Warmth', 'Pain' as the case may be. I shall give you a 'ready' signal, each time before I touch your skin. Try to express the intensity of the stimulus as clearly as you can, stating whether it is 'Weak', 'Moderate', or 'Strong".*

(6) The Experimenter always sees that the temperature of the cold water remains approximately 5° C. throughout the whole experiment.

(7) One of the metal cones is then taken out from the cup, wiped quickly with the drying cloth and applied on the middle point of any cell of the square marked on the skin, after a 'ready' signal is given. Touching the skin and taking off—this whole operation should be completed within a second. The pressure on the skin should approximately be constant for each point. After a pause of 5 seconds, another point is explored and the midpoint of the different cells of the Square are thus randomly explored one by one.

(8) The metal cone is changed after each 2 applications.

(9) The response of the subject is noted symbolically just on the respective cell of the Square marked on the note book.

Part 2—*Warm Spots.*

The Procedure and the instruction is the same, except that the water temperature is kept at 50° centigrade. The same area is chosen in which Cold Spot is already explored. The responses of the subject are noted in the same way on another stamp marked on the note book.

Part 3—*Demonstration of Paradoxical Cold.*

The procedure is the same as before. Here both Cold (5° C.) and Hot (50° C.) water are used randomly as the stimuli on the same area where Cold and warmth Spots have already been explored. Three fresh Squares are marked on the note book to record the responses

(1) when cold stimulus is applied in each of the cells,

(2) when hot stimulus is applied in each of the cells

and (3) to show the points where paradoxical cold occurred. The last Square is filled up after and according to the former two. The points of Paradoxical Cold are those in which 'Cold' responses are reported even when 'Warm' stimulus is applied.

The reports of cold and warmth spots in this part of the experiment also furnish the reliability (stability) of the cold and warmth spots.

RESULTS:

The principal result is the map of the volar surface of the forearm indicating the number of cold and warm spots and the number of every intensive step for both sensations. The results should be entered in a table like the following.

Area Used	Cold Spots.				Warmth Spots.			
	Intensity			Total	Intensity			Total
	Weak	Moderate	Strong		Weak	Moderate	Strong	

Both cold and warm spots should be shown with black and white circles (● & O) in a fresh stamp on the note book. The points of Paradoxical cold may also be shown in the same map using another symbol.

DISCUSSIONS:

The following questions should be answered:—

(1) What is the nature of distribution (Haphazard or clustered) of cold and warmth spots ?

(2) Which one is more stable ? Indicate the percentage verified in the second testing.

(3) Indicate the number of cells in which both types of sensitivity were reported.

(4) Indicate the number of cells in which paradoxical cold was reported. Are they clustered or haphazard ?

(5) With what end-organs are the two senses said to be correlated ? Have there been any experiments which tend to disprove the identification of different end-organs with them ? Explain your answer.

REFERENCES:

1. Dallenbach's chapter in E. G. Boring, H.S. Langfeld & H.P. Weld's *Introduction to Psychology* (1939) and *Psychology* (1935)
2. Nafe, J. P. "The pressure, pain and temperature senses." In *Handbook of General Experimental Psychology* by Carl Murchison.
3. Woodworth, R. S, *Experimental Psychology* (1938)
4. Dallenbach's 'The Temperature spots and end-organs' in Wheeler's (Edit) *Readings in Science of Psychology* (1930)

EXPERIMENT 3

Mapping out Pain and Pressure Spots

INTRODUCTION:

If our skin is punctiformly stimulated with graduated mechanical stimuli, it will afford two stimulus thresholds. The lower one is for the pressure sensation and the higher one for pain. Pressure is aroused by a distortion of the skin whereas pain due to the injury to the free-nerve endings. The distortion may be either positive or negative; that is to say, the end-organs of pressure respond to a "pull" as well as to a "push". Von Frey and Kiesow (1899) have shown that pressure is experienced when a gradient is formed upon the skin and that, whether the direction of force is outward or inward, the sensation felt is the same. Von Frey's experiment aimed to make sure whether the pain sense was separate from the pressure sense. He knew of course that strong pressure was likely to give pain, while light pressure only a sensation of contact. Accordingly, he devised a method of calibrating bristle hairs by the area at the point of contact and the weight required to bend the hair. The pressure on the hair was measured by substituting a delicate weighing balance for the skin. The diameter of each hair was measured by a Microscope. These values he expressed in gram-millimeters. (gm. m.m.) A graduated series of hairs being prepared, the threshold of any spot of the skin was determined by ascertaining the weakest hair that gave rise to a sensation of pressure. Thus the stimulus threshold for pressure in front portion of forearm was 8 gm. m.m. whereas for pain it rose to 20 gm. m.m. Von Frey not only became sure that pain and pressure are two sensations, but they are also separate in location. Thus there were two sets of spots he explored, one with low threshold giving sensation of contact or pressure, and the other with high threshold giving sensation of Pain. The distribution of the two sets is also different, as the pressure spots are clustered near the roots of the hair, while the pain spots are scattered over the whole surface. Pain spots are most numerous where the large nerves and blood vessels come nearest to the surface of the skin.

The present experiment studies the distribution of both pain and pressure spots and attempts to familiarise the subject introspectively with the qualities experienced for both the sensations.

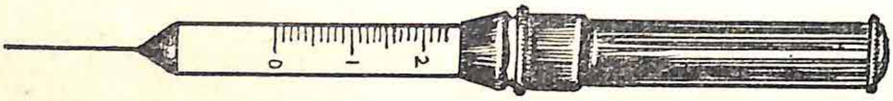

Fig 3. Von Frey's Hair aesthesiometer
(Manufactured by The Technical Corporation, Lucknow)

MATERIALS:

1. 1 Von Frey's Hair aesthesiometer (Fig.3).
2. Blindfold.
3. Stamp-grid.
4. Ink-Pad.
5. Magnifying Glass.
6. Some Ether to anesthetize.
7. Safety-razor.
8. 1 Algometer.

PROCEDURE :

The experiment is divided into two parts. The first deals with exploration of Pressure Spots and the second with Pain Spots.

Part 1.

(1) The area selected for experiment is marked by the stamp and its map taken on the

note book. With a magnifying glass the hairs on the experimental area are located and their proper positions drawn on the map.

2. The area is shaved in order to avoid stimulating it by touching one of the hairs.

3. The proper stimulus for arousing the pressure sense is selected by the following method.

(a) At least 10 different sizes of hair bristle of the Hair aesthesiometer are tried one by one each with a just noticeable curvature on the area to be explored and the minimum length to arouse the sensation is noted.

(b) Then the experimental area is anesthetized by spraying Ether upon it. When cutaneous sensitivity is lost, all the different lengths of the hair are applied in turn and those that arouse the sensation are discarded because they are exciting the subcutaneous tissue. Between the minimum value for the normal skin and the minimum for the anesthetized skin, any one is selected.

4. After the proper stimulus has been selected it should be applied point by point to the entire area to be explored and the positions at which the pressure qualities are elicited, are recorded on the corresponding map stamped on the note book.

5. In order to keep the pressure constant, the hair of the aesthesiometer should be bent at every application to approximately the same degree. It should be pressed until a just noticeable curvature on the bristle is observed.

6. Before the experiment proper begins, the 'S' should be given the following instructions :—

"You will be stimulated after a 'ready' signal with the end of a horse-hair which will not hurt you any way. Report when an experience is aroused and describe its quality, stating whether it is 'solid', 'clear', 'dull' or 'burning.'"

The reports taken on the accompanying map should also include the qualities reported by some suitable symbols.

7. A second test is made on the same area after 15 minutes to examine the stability of the pressure spots.

Part 2. (Exploration of Pain Spots)

If the Algometer is not available, then the Hair aesthesiometer is used. The length of the boar bristle of the Hair aesthesiometer should be 1/3 of the bristle used to stimulate the pressure sense.

The procedure here is the same as in the previous experiment and the same area is again explored for Pain Spots. The instruction to the subject is exactly the same. A second retesting is also done here after 15 minutes. The reports along with the qualities experienced are noted on another map.

RESULTS:

The principal result is presented in one map which should show the distribution of Pressure and Pain Spots and also of hairs. A table like the following is prepared to show the number of Pressure and Pain Spots of every quality.

Area Explored	Sensitivity	Qualities Experienced.				Total	Percentage Verified.
		Solid	Clear	Dull	Burning		
	Pressure						
	Pain						

DISCUSSIONS:-

The following questions should be discussed:—

1. What relation exists between the Pressure Spots, Pain Spots and the hairs ? Are the Pressure Spots clustered near the hair roots ? Do Pressure Spots occur in hairless region ?
2. Compare Pressure Spots and Pain Spots in terms of their distributions.
3. How does the frequency of the Spots vary ?
4. From your results can you distinguish the two senses in terms of their qualities ?
5. Which end organs have been identified as Pressure receptors and how are the end organs thrown into function ? (See Dallenbach's 'Somesthesis' in Boring, Langfeld and Weld's *Psychology,* Page 160).
6. How is the Pain Sensitivity explained ?

REFERENCES:-

1. Nafe's 'The pressure, pain and temperature Senses' in Murchison's (Editor), *Hand book of General Experimental Psychology* (1934).
2. Dallenbach's 'Somesthesis' in Boring, Langfeld and Weld's *Psychology* (1935).
3. R. S. Woodworth—*Experimental Psychology* (1938).

EXPERIMENT 4

Errors in Cutaneous Localization

INTRODUCTION:

Nobody perhaps confuses a pinch on the finger with a pinch at the back of the hand. We don't confuse a fly alighting on our forehead with the one on the neck. The part of the body stimulated can be pointed out with very little error. In any event, the errors are never very large The maximum error reported so far has been 13 m.m.

Accuracy of localization varies for different parts of the skin. In general, the portions of the skin which are mostly involved in tactual perceptions are most sensitive. Thus less errors are found in localizing the point stimulated at or near the wrist than in localizing the point on the middle of the forearm.

The probable direction of error is also predicted by this general rule. The point touched is generally mistaken to be toward the nearest joint or actively used portion of the skin in the localization. Thus the largest errors are along the axis of the arm unless the point touched is on, or very close to the wrist. The errors in the radial and ulnar directions are small.

The purpose of the present experiment is to verify the above two general assumptions. It also attempts to study introspectively the criteria by which the subject recognises the location of a touch, the cues which help his localization—in a word, what constitutes the 'Local sign'. *

MATERIALS :

1. Two blunt pointed pencils.
2. One Sheet of tissue paper.
3. A Millimeter scale.

PROCEDURE:

1. A rectangle of 30 m m. by 10 m.m. is marked off by ink dots on the volar (inner) surface, starting from the wrist to the forearm. This area is divided in 3 equal squares each having its side 10 m m. long.
2. The tissue paper is kept on the subject's hand as it rests, palm downward on the table and the outline of his hand, the veins, scars, knuckles and other distinguishable points at the experimental area are traced.
3. 20 different points randomly distributed are marked on each of the squares traced on the paper which are to be stimulated accordingly on the experimental area with the tip of the blunt pencil, in a random order.
4. The subject is blindfolded and a pencil handed to him after the following instructions have been given:—

   "I am going to touch a spot on your forearm with a pencil. Immediately I remove my pencil, you are to place the point of your pencil on the spot that I have touched. You please do it as soon as you can. The first point that you touch would be counted.

   Apart from this, you have to mention after each 5 trials, the criteria which formed the basis of your localization, in other words you have to tell me what made you think that the point indicated, was the point touched by me".
5. The total 60 points, which are hitherto referred as 'R' (stimulus) points are stimulated one by one in a random order, according to the schedule prepared before the actual experiment. After each stimulation, the point touched by the subject in response is traced in the chart and it is

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* The character by which one point is distinguished from another in a sensitive surface is called 'Local Sign', a name first given by Lotze.

designated as 'L' (Localization) points. The serial number of the 'L' point is also written on this chart according to the serial number of the 'R' point.

6. After each 5 stimulations, the subject is asked for his introspective report.
7. After all the 60 points have been touched and subsequently localized, lines are drawn to join each 'R' points with their respective 'L' points. The length of the lines measured in mm. gives the magnitude of error for the respective stimulus points.
8. The direction of error for each stimulus point is also noted on the same chart by means of arrow.

RESULTS:

The principal result is the chart showing the magnitude and direction of error for each stimulus point. The raw data shown on the chart is tabulated in a table like the following where the 60 stimulus points are categorised according to the 3 experimental areas. (Not according to serial number).

Trial	Area experimented	Error in mm.	Direction of error.	Is the direction near the actively used part ?
	Near the wrist			
	Average			
	Lower forearm (Middle of the hand)			
	Average			
	Forearm (Near Knuckles)			
	Average			

DISCUSSIONS:

The following questions should be answered:—

1. Did the two assumptions with which the experiment started, come out true ? Was there the maximum error for forearm and minimum for portions just above the wrist ? Is the probable direction of an error predictable ? Can you postulate any theory to explain tactual localization based on your findings ?
2. Upon what cues does the localization depend ? Which of the cues your subject could introspect ? Is it difficult to discover by introspection just what constitutes the local-sign ? Explain.
3. "Tactual space is inseparably bound up with Visual space". How far does the introspective data obtained, support the above statement ?
4. State critically how far Lotze's theory of 'Local Sign' explains our accuracy of tactual localization.

Hints:— (Lotze postulated a special 'quality' (Local Sign) for every nerve and upon the basis of its peculiar quality the experience for locality is said to be felt. The doctrine of 'Local Sign' is still supported and there is some proof of it. There is much more evidence for 'Local Sign' even if we don't interpret Lotze's 'quality' strictly. The fibres having individual terminations within the C. N. S form a sufficient basis for us by which differentiation can be made.

Hoagland has presented factual evidence in his article 'A basis for cutaneous localization' in *Journal of General Psy.* 1932. Vol 6. Pp. 468—470. which supports this view).

REFERENCES:

1. Paterson, J. "Local signs as orientation tendencies" *Psy. Rev.* 1926, 33, Pp. 218-236, Abridged in W. L. Valentine's "*Readings in Experimental Psychology*" Pp. 380-389.
2. Munn, N. L. "*Psychology*" Pp. 386-388.
3. Boring, Langfeld & Weld. "*Psychology*" Pp. 207-208.
4. Ruch, T. C.-"Somatic sensation" in J. F. Fulton (Edit) "*Howell's Text-book of Physiology*" Pp. 326-332.

EXPERIMENT 5

Mapping out the Blind-Spot

INTRODUCTION:

The human retina is not sensitive to every visual stimulus that comes across it. We are not aware of the fact that the peripheries of our eyes are colour blind until we test it in the laboratory. In the same way, we are never made aware of the fact that a certain part of the retina where the optic nerve enters the eye-ball interrupting the rods and cones, is totally blind. This part is called Blind-Spot. Consequently, any object which is focussed on the Blind-Spot is invisible. There is almost no rod or cone here and hence no sensation is produced.

The Blind-Spot is very small in area and elliptical in shape but it can be mapped out on a paper and its approximate size can be determined by trigonometrical calculations. The Blind-Spot for right eye can be mapped only on the right central horizontal line of our field of vision and for left eye on the left horizontal line because Blind-Spot is situated on the inner or nasal side of the retina.

The present experiment demonstrates the presence of Blind-Spot on our retina and attempts to map its area.

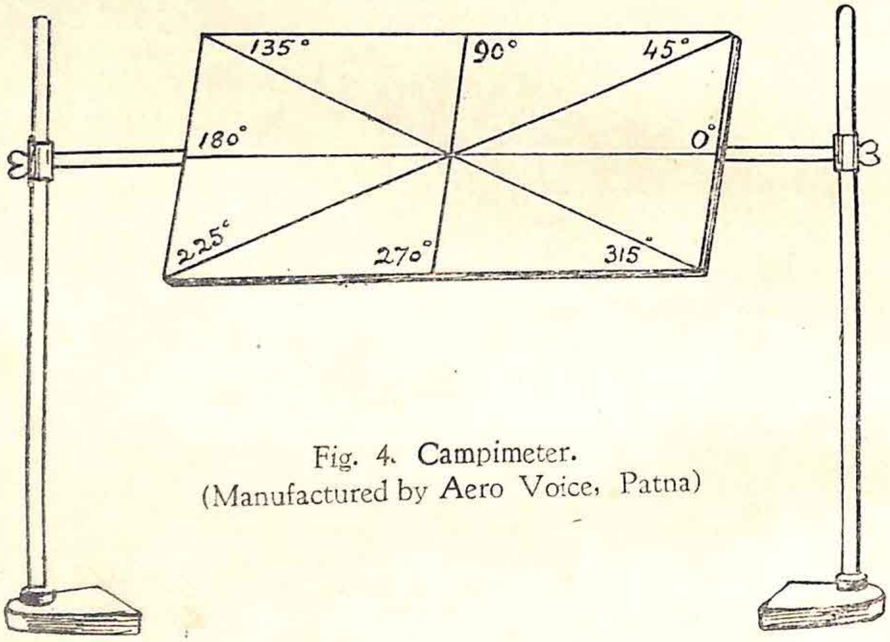

Fig. 4. Campimeter.
(Manufactured by Aero Voice, Patna)

MATERIALS:

1. A Campimeter (Fig. 4) made of grey Card board. Centimeter Scales are drawn lengthwise, breadthwise & diagonally, intersecting at the centre of the board. It is supported lengthwise by two iron stands. The adjustable clamps fix the Campimeter at different angles or heights.
2. Small Squares of Red paper fixed on a rider.
3. Chin-rest. ✓
4. Spirit level.
5. Measuring Rod.
6. Eye-shade.

PROCEDURE:

1. The 'S' is asked to sit on a chair and a chin-rest is kept before him at the distance of 18″ from the Campimeter. The Campimeter should be placed in such a position that it gets sufficient amount of light on it. The height of the Campimeter should be such that the eye of the 'S' lies on the level of the intersecting point.

2. The 'S's right eye should be blindfolded if Blind-Spot for left eye is to be mapped, otherwise vice versa.

3. The 'S' is instructed as follows:—

   "Please concentrate yourself on the fixation point where the horizontal and vertical lines intersect at the Campimeter. Something will be shown to you after a 'ready' signal is given. When you see it, report its presence by saying 'yes', when not, say 'no'. Whether you are able to see it or not, don't move your head from the chin-rest and your eye from the fixation point".

4. The 'S' is repeatedly cautioned not to look directly on the stimulus strip.

5. The Red strip mounted on the rider is now moved on the right horizontal axis from the peripheral side towards the centre if Blind-Spot for right eye is to be mapped. For left eye, it should be moved on the left horizontal axis from the peripheral side towards the central. The respective axis may be called the axis of 0° (for Right) or 180° (for left eye). The point where the 'S' reports appearance of the stimulus is noted and he is asked to report the colour of the stimulus. From this point the strip is moved slowly towards the centre and the point of appearance and disappearance of the stimulus in this field of vision is noted in a table. (See Results). The movement from periphery to the centre is called 'Incoming' and from the centre to the periphery 'Outgoing'. 5 Incoming and 5 Outgoing trials are followed successively each after a rest pause of 1 minute.

   By this procedure the length of the Blind-Spot is mapped but its width still remains unmapped.

5. In order to find the width of the Blind-Spot the following procedure may be followed:—

   Imagine a vertical st. line intersecting the mid-point of the distance where happened in all the trials a total disappearance of the stimulus strip due to Blind-Spot. On that imaginary line move the stimulus once above the central line, once below the central line. The points up to which the total disappearance remains, mark the width of the Blind-Spot. The length is noted.

RESULTS:

The principal result is the map of the

Trial	Order (In coming or Outgoing)	Distance in mm.		
		Appeared from 0 to	Disappeared from	Reappeared from
1				
2				
3				
...				
...				
10				
Average Length of the Blind-Spot				

Blind-Spot and a table showing its length on Axis 0° in different trials.

DISCUSSIONS:

The questions to be discussed here are:—

1. How large is your subject's Blind-Spot? Is it possible to map out the exact size of the Blind-Spot? What are the limitations?
2. Are we normally aware of this 'blindness', in the visual field? Why not? [Hints: Because we are continually filling in the Blind-Spot on the basis of the surrounding areas (cf. Law of closure in Perception) and moreover when two eyes are working in co-operation, their fields of vision overlap].

REFERENCES:

Troland, L. T. *"The Principles of Psychophysiology"* (1929) Vol-1.

Bartley, S. H. *"Vision"*, Chap. 5. Pp. 94-116.

EXPERIMENT 6

Mapping out Retinal Zones

INTRODUCTION:

In human retina there are three zones. All zones are sensitive for specific colours. The inner zone is the area of complete colour and colourless sensation, the middle zone is colour blind to reds and greens, although blues and yellows are seen. In the outer zone, total colour blindness occurs and only brightness can be experienced. The field of brightness is accordingly much larger than that for colours, while blues and yellows have a larger field than reds and greens. This distribution may be overlapping at certain points and thus the three zones are not rigidly separated.

In the present experiment, we have to map out the different retinal zones for left eye on a Perimeter.

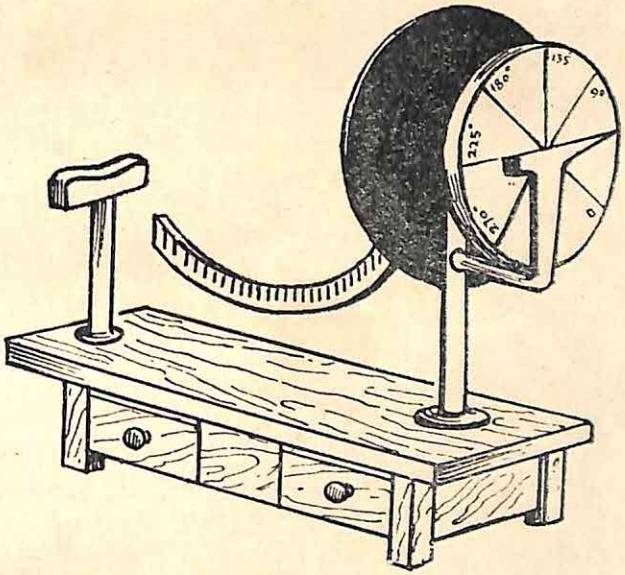

Fig. 5. Perimeter.
(Manufactured by Aero Voice, Patna.)

MATERIALS:

1. Perimeter* as that shown in Fig. 5. is made of wood and consists essentially of (a) a chin-rest whose height is adjustable.

(b) Two round discs, one small and the other big attached on a horizontal bar. On the back of the discs angles from 0° to 360° are marked and an iron rod acts as the pointer.

(c) A long quadrant iron bar 1″ width. This is called Perimeter arm. A scale from 0° to 100° showing angular distance is marked on it. In this bar the stimulus strip is fixed on a rider attached with the bar. This iron curvature (Perimeter arm) is attached with the smaller disc in such a way that whenever the former is rotated in a circular way the latter also moves. The pointer should be parallel to the axis of 0° when the Perimeter arm is just lying vertical to the plane.

2. Eye-shade.
3. Square strips of white, red, green, blue and yellow colour.
4. A stick to move the rider.

---

* A Hand Perimeter (Fig. 6) may also be used.

PROCEDURE:

1. The 'S' is seated with his back to the light and his right eye is blind-folded in such a way that the vision of his left eye is not interfered.
2. The 'S' is asked to put his chin on the chin-rest, the height of which is adjusted in such a way that the fixation point on the bigger disc lies in the direct line of the Subject's vision.

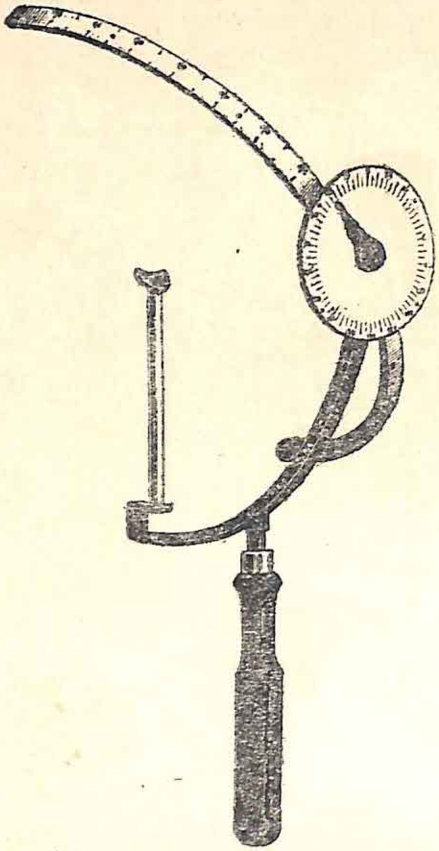

Fig. 6. A Hand Perimeter.
Manufactured by
The Technical Corporation, Lucknow.

3. The perimeter arm is adjusted in the left horizontal position (may be called 180°) with the rider in extreme periphery.

   The following instruction is then given to the 'S'—:

   "You please fixate your left eye on the black point visible in front of you I will put something on the iron curvature and you please tell whether you are able to see it s colour without moving your eyes from the fixation point. Don't see the thing directly and never move your eye from the fixation point."

4. Without the Subject's knowledge, a colour strip is fixed on the rider of the perimeter arm and it is moved by a stick from the extreme end of the perimeter arm towards the centre with as near uniform speed as possible but the speed should not be too slow nor too rapid. When the Subject sees the colour of the stimulus strip, the position of it on the perimeter arm is recorded and the movement towards the fixation point is still continued only on this angle (Axis 180°), to map out the blind spot of the left eye.

5. 4 readings (all incoming) each with Red, Green, Yellow, Blue, and White stimulus-strip are taken and a rest pause of 2 minutes is given after each trial so as to check retinal fatigue.

6. The same procedure is repeated on the opposite side of the perimeter arm (may be called (°), the upper and the lower quadrants of the visual field (Axis 90° and 270° respectively) with the exception that the rider is stopped moving towards the fixation point, after the point of appearance of the stimulus-strip is noted for the trial. If time permits, angles of 45°, 135°, 225°, and 315° should also be explored.

RESULTS:

1. The records for different trials on different Axis for each of the colour strips are tabulated in a table given on the next page.

2. The average extension of each of the colours clearly seen is determined for each axis and on a perimetric chart (See Munn) the extensions of the different colours are plotted, using coloured lines to represent the colours. The Blind-Spot for left eye is shown on the 180° Axis, with a black dot.

3. The colour changes (if any) for different stimulus in different zones should be mentioned.

DISCUSSIONS :

The following questions should be answered:—

1. Are the zones absolute ? If not, why ? Do you hope to get the same result if stimulus strips of different size, shape and saturation are used ?

2. How are the results of this experiment explained according to the Young Helmholtz's and Hering's theory of colour vision ? (See Bill's, *General Experimental Psychology* Pp. 57-66 in this connection).

REFERENCES :

1. Woodworth, R. S. & Scholosberg, H—*Experimental Psychology* (1954)—Revised Edition. Pp. 395-396.
2. Mary Collins & James Drever—*Experimental Psychology* Pp. 45-48.
3. Bills, A.G.—*General Experimental Psychology* (1939)
4. Valentine, W. L.—*Readings in Experimental Psychology* (1931) Pp. 370-375.
5. Munn, N. L.—*Psychology,* Chapter on 'Vision'.

EXPERIMENT 7

The After-Effects of Retinal Stimulation.

INTRODUCTION:

Some of us must have felt astonished to find everything appearing to him yellowish when he removed his goggles of Blue Glass from his eyes. Had the glasses been green, objects would have seemed to him reddish in tinge. Such examples occur in our everyday life but they remain unexplained. The above illustration is a simple case of after-effect of Retinal Stimulation giving Negative after-sensation. "The total response of the visual apparatus to a light of any considerable intensity lasts for sometime even after the cessation of the stimulus"*. This is called 'After-Lag' or 'After-Effects of Retinal Stimulation'. Due to this 'after-lag', the removal of a stimulus, no matter of what colour it be, is followed by the appearance of a Complementary Colour or a Colour of the same hue but diminished in intensity, depending on the stimulus field (Post-exposure) affecting the retina after the primary stimulus is removed. If a Complementary Colour appears after the removal of the Stimulus, it is called Negative Afterimage; if followed by the same hue, it is called Positive Afterimage. Such phenomena are also described as Successive Contrast and they take place frequently.

Though it takes some practice to observe the phenomena, because, as Woodworth puts, "it is one of those subjective phenomena which our whole practical life leads us to disregard.It is subjective......, but it is definitely sensory and not imaginary. It indicates some peculiarity of the retinal or cortical response."*The presence of afterimages in animals have neatly been demonstrated by Frohlich (1922),Granit (1933) and many others. Frohlich's String Galvanometer records of the retinal potential from the Cephalopod eye show that the rhythmic activity goes on even after illumination ceases and we can well believe that with this as indication, after-discharge is occurring in the peripheral nerve units and consequently afterimages.

The occurrence of a positive or a negative afterimage depends primarily upon two variables, the strength of the after-effects and the brightness of the post-exposure field; the field upon which the afterimage is projected. The strength of the after-effect can indirectly be inferred from the intensity of the original stimulus, the time since the stimulus ceased to act and the time of fixation on the original stimulus.

In the present experiment we have to observe the phenomena of positive and negative afterimages and the influence of the above two variables on them.

MATERIALS:

For Positive Afterimage.

(1) A 200-watt lamp with a long straight filament.
(2) A projection lantern.
(3) Red, Green, Blue & Yellow Slides.

For Negative Afterimage.

(1) Square strips of Red, Green, Yellow & Blue of Equal Size.
(2) Sheets of light grey, light green & light red colour
(3) A stop-watch.
(4) A Chin-rest.

PROCEDURE:

The first part of the experiment deals with positive afterimage and the flight of colours, first demonstrated by Helmholtz. The second part is concerned with negative after-effects.

---

* From R. S. Woodworth, *Experimental Psychology* (1938) By permission of Henry Holt & Co., New York.

Part 1:—

1. The experiment is performed in a dark room and the subject is called in the room at least 5 minutes before the experiment starts.
2. The location of the lamp is shown to him and the following instruction given:—

   "At a 'ready' signal you are to look in the direction of the lamp and get ready to fixate the light when it appears and observe it minutely so that you can answer any question asked later."

3. The lamp is flashed on and after 30 seconds turned off. The subject is asked whether the filament was apparent after the lamp was turned off. If so, what was its colour immediately after the cessation of the light? Does he see any sequence of colour changes. This trial is for white stimulus.
4. The procedure in experiments with other colours is exactly the same. Here the different colour slides are projected by a projection lantern and the projection lantern is turned off according to the fixation period.
5. 2 readings are taken with each of the stimuli fixated for 30 seconds, 1 minute & 5 minutes with a rest pause of 2 minutes after each trial. The essential results may be recorded in a table like the following:—

Stimulus	Time Fixated	Duration of Positive afterimage	No. of Appearance & Reappearance	Successive Colour Changes.	Any Other Remark.

Part 2:—

1. The Experiment is conducted in a well illuminated room where illumination is supposed to be constant.
2. One of the colour strips with a black point on it, is pasted on a screen, and one of the big paper sheets (preferably of light grey) is pasted on another screen for preparing 'post-exposure field'.
3. The subject is seated comfortably in a chair and his chin is placed on a chin-rest that stands on a table. The height of the chin-rest is adjusted according to the subject's comfort and care is taken that he gets a clear view of the stimulus strip pasted on the screen. The subject is given the following instruction:—

   "After a 'ready' signal, you please fix your eyes on the point marked in the colour strip. Close one of your eyes which may facilitate your concentration on the point. Don't move your eye from the point and

observe it minutely. You have to report what you will see on another screen, that would appear immediately after the screen, bearing the coloured patch, is removed. Whether your field of vision is removed from you or not, keep your eye fixated. Don't move it at all and observe the screen minutely so that you are able to report the delay of the appearance and disappearance of the afterimage, its colour, size, shape and number of its appearance. You please give a 'tick' (sound) without moving your eye when any thing comes on the new screen".

4. After 30 seconds the screen bearing the stimulus strip is removed and in its place comes another screen. This operation should be such that it does not disturb the subject's concentration. When the subject gives the 'tick' sound to indicate the appearance of the afterimage, the time is recorded. This shows the delay of appearance of the afterimage. When the subject stops seeing anything on the new screen after some time, he is asked all the questions already stated to him and they are entered into a table like the following:—

Stimulus* & its intensity	Colour of the post-exposure field	Duration of fixation	Delay of appearance	Colour, size, & brightness of the afterimage	Number of appearance & disappearance	Any other phenomena associated

5. 2 readings are taken with each of the stimulus strip fixated for 30 seconds, 1 minute and 15 minutes, the post-exposure field being light grey in each case. A rest pause of 2 minutes should follow every trial.

With Light Red and Light Green as post-exposure field, coloured patch of Red is also experimented to verify whether Red projected on a Green background produces a highly saturated Green but produces a gray one if projected on a Red background. A similar experiment with Green stimulus patch may be carried on if time permits.

DISCUSSIONS:

The following questions should be answered with reference to the results obtained:—

1. What relations exist between the colour seen during the retinal stimulation and the colour seen after the retinal stimulation ? Does it really affect the kind of afterimage obtained ?
2. Does time of fixation influence the nature of afterimage, its duration, intensity and number of appearance and disappearance ? If so, in what way ? Show with a graph, how the frequencies of reappearance of both types of afterimage vary with the time of fixation.

---

*The samples of the coloured patches may be pasted in this column.

3. What are the shortcomings of the Young Helmholtz's and Hering's theory of colour vision in explaining your results ?

4. How do you like Ebbeck's theory ? Which of the theories seems most satisfactory to explain your results ?

REFERENCES:

1. Woodworth, R. S.-*Experimental Psychology*.
2. Collins & Drever's *Experimental Psychology*.
3. Graham, C. Chapter on "Vision III" in Carl Murchison's (Edit.)—*Handbook of General Experimental Psychology*.

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EXPERIMENT 8

D. L. For Lifted Weights

INTRODUCTION:

A fundamental fact in Psychology as well as in Physiology lends the idea that the difference between two stimuli lying in the same continuum must reach a certain point in order to be perceived as two. This difference between two stimuli necessary to produce two discriminable impressions is known as the difference threshold. As a symbol for difference threshold (Limen), we use the abbreviation D. L. The D. L. is statistically defined as the stimulus difference that is noticed exactly 50 per cent of the times while comparing two different stimulus values lying in the same continuum. "And the smallest possible, difference between the impression, which results from a liminal stimulus difference, is, known as a 'Just Noticeable Difference' (J. N. D.)"

The difference threshold is illustrated by many everyday experiences. When a bright light of 60 candle power is already burning, the addition of a 10 candle power is not likely to make the room perceptibly brighter. This is below the D. L. for the 60 candle power and thus it cannot bring a just noticeable difference in the brightness of the illumination.

The stars are invisible by day because they add absolutely nothing to the brightness of the sky.

The difference threshold can be found by different psycho-physical methods but the most commonly used method among them, is the Method of Constant Stimulus Difference. In the constant method, each stimulus is presented simultaneously with or in temporal sequence with a single standard and the subject is to report whether the variable stimuli are apparently 'greater' or "lesser' than the 'standard'. These are two categoric judgements. In three categoric judgements, the response of 'equal' or 'doubtful' is also added.

The Method of Constant Stimulus Difference (with three categoric judgements) has been used in the present experiment to determine the differential limen for lifted weights.

MATERIALS:

1. Set of 7 weights, 85, 90, 95, 100, 105, 110 and 115 grams. (If prepared weights are not available, the required weights can be made with lead shots poured in small phials and measured by weighing balance).
2. Another weight of 100 grams. (standard).
3. A felt or any soft cloth where the subject's hand should rest.
4. Metronome set at 60.
5. A Screen.

PROCEDURE:

1. Before the experiment starts, the Experimenter ('E') prepares a table without the knowledge of the Subject to maintain the following:—

(a) The standard is presented before the variable stimuli in half of the observations and in half, it is given after the variables in a random fashion. This is done to cancel out the 'constant time error'.

(b) Every variable follows every other an equal number of times. This is done to counterbalance 'Intra-serial effect'.

(c) Each pair of weight (standard and variable) is judged equal number of times. (usually 50 readings are taken for each pair of stimulus. Thus the total number of readings here will be 350).

2. The subject is seated comfortably and his arm is placed on the soft felt, some 4" thick so that his hand hangs freely in a position to grasp with a simple wrist movement any weight that is brought within his reach.
3. The metronome is set to beat seconds with the bell sounding every fourth second.

The 'S' is given 5 preliminary practice trials in lifting the weights as timed by the metronome. He lifts one weight at the sound of the bell, sets it down at the second stroke, removes his hand, and waits for the bell again, at which moment he lifts the second weight for 1 second. A pause of 10 seconds is given between pairs during which the subject makes his judgement. He is given the following instruction concerning his judgement:-

"Say 'Heavier' when the second weight is heavier than the first, say 'Equal' when the second weight is equal to the first and say 'Lighter' when the second weight is lighter than the first".

The judgement given by the subject is noted against the respective pair of stimuli for which it is given.

4. The subject is asked frequently to describe the criteria he used in judging the weights.

RESULTS:

The principal result is presented in a table like the following showing the proportions of judgement 'H', 'E' and 'L' for every variable stimulus.

The table is also graphically shown with proportions in the 'Y' axis and stimulus value on the 'X' axis. Such a graph shows what is called "Psychometric function". The next task is to determine the value of L_l and L_u, the lower and upper limens. L_l is given by the value of the stimulus at which the 'Psychometric function' of the 'Lighter' judgement crosses the 50% line in the graph. The point is marked on the 'L' judgement graph and it is plotted against the adjacent stimuli. This reading will be L_l. This process of finding L_l is called linear interpolation. The value of L_u is found in the same way. The L_l is also called M_b (Mean of the basal value) and similarly L_u is called M_a (Mean of the apical value). These values can be arithmetically checked by the following formulae* given by Woodworth.

Stimulus value (gm.)	Proportion		
	H	E	L
85			
90			
95			
100			
105			
110			
115			

$$M_a = A - i/2 - i \text{ Sum } a$$
$$M_b = B + i/2 + i \text{ Sum } b$$

where A = stimulus value (Apical) where 'H' Judgement is cent per cent,
B = stimulus value (Basal) where 'L' Judgement is cent percent,
i = step interval,
Sum a = Sum of Proportions of 'H' Judgements.
Sum b = Sum of Proportions of 'L' Judgements.

The final task is to compute the D. L. by the following formula:—

$$D.\ L. = \frac{M_a - M_b}{2}$$

---

* From Woodworth, R. S. *Experimental Psychology* (1938) Page 421.
By permission of Henry Holt & Co., New York.

The S. D. of the 'H' and 'L' judgements should also be calculated by the formulae.*:—

$$S.D._a = i\sqrt{2\ \text{Sum } a' - \text{Sum } a\ (1 + \text{Sum } a)}$$

$$S.D._b = i\sqrt{2\ \text{Sum } b' - \text{Sum } b\ (1 + \text{Sum } b)}$$

where Sum a' = sum of the cumulative proportion of 'H' Judgements,

Sum b' = Sum of the cumulative proportion of 'L' Judgements.

$$\text{The Average S. D.} = \frac{S.D._a + S.D._b}{2}$$

The other statistics to be computed here are P. S. E. (Point of Subjective Equality, the midpoint between L_u and L_l.) & C.E. (constant error). These are computed by the formula

$$P.S.E = \frac{M_a + M_b}{2}$$

and C. E = P. S. E. – 'Standard' Stimulus.

The above statistics should also be tabulated

DISCUSSIONS:-

The following questions should be answered with reference to the results obtained:—

1. Say from the C.E. whether your subject overestimated or underestimated. From P.S.E. say, which stimulus value was taken as the 'standard'.
2. Describe from the D.L., how sensitive your Subject is. Does D.L. really measure the subject's discrimination ? Which do you think better as the estimate of your Subject's sensitivity, the S. D. or the D. L. ? (cf. Woodworth, R. S.—*Experimental Psychology* p. 422)
3. Can you say whether your result verifies Weber's law ? (Hints:—From the D. L. determine the Weber's Ratio, by the formula D. L./Standard. If it be 1/30, then the law is verified for lifted weights. But in practice, it never comes. to be so. Even if it comes to be so, it must be by chance.) Suggest any better method for verifying Weber's law. (Hints:—Repeat the same experiment with another 3 Sets of Weight, the 'standard' being, say, 50 grams, 150 grams and 200 grams and find the D.L. for each of the Set, and see whether the Weber's Ratio remains constant in every case. If it be constant, the Weber's law can be said to have been verified).
4. What are the defects of the Method of Constant Stimulus Presentation ? What should be the preferred Mathematical process in computing the D.L. ? (See especially Guilford's *Psychometric Methods*, Page 198).

REFERENCES:

1. Woodworth, R.S. *Experimental Psychology.* Pp. 400-425.
2. Guilford. J. P. *Psychometric Methods.* (1936) Pp. 186-211.
3. Underwood, B. J. *Experimental Psychology.* Pp. 65-81.
4. Schulze, R. *Experimental Psychology and Pedagogy.* (Translated by Pinter, R.)— Pp. 83-85 Chapter on 'The measurement of Sensation'.

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* From Woodworth, R. S. *Experimental Psychology* (1938) Page 421. By permission of Henry Holt & Co, New York.

EXPERIMENT 9

Differentiation of Visual Extent.

INTRODUCTION:

It is said that error in perception though probably slight, is a usual phenomenon. We do not always see things as they exist in the physically measured reality. Some deviations happen to be there at times and such error is quite natural where ability of finer discrimination is required. Investigations have shown that it is possible to make finer discrimination in visual experience than any other field of experience. Yet there are many people who fail to discriminate small differences. It falls within the province of psychology to make accurate test of human capacities to discriminate small differences. The tendency and extent of error due to approximation by an individual can best be known by the Method of Average Error.

The Method of Average Error came into the field of Psychophysics with the interest in the study of the precision of observation or the precision of matching procedure. It was designed to study the errors which enter into our observations. In this method, a constant 'standard' stimulus is presented and the subject is asked to adjust a 'variable' stimulus apparently equal to the standard. He is given a number of trials and the deviations that he makes in every adjustment are taken as his errors. The Mean of these absolute errors in adjustment gives the 'Average Error'. The S. D. of the length of adjustment for all the trials gives a measure of the sensitivity of the Subject.

The present experiment is a study to see how accurately the subject can adjust a variable line with a given standard line. In short, this studies his accuracy in discrimination of linear magnitude by the Method of Average Error.

MATERIALS :

1. Galton bar. (Fig. 7)
2. Chin-rest.
3. Spirit level.
4. 2 stands with clamps.

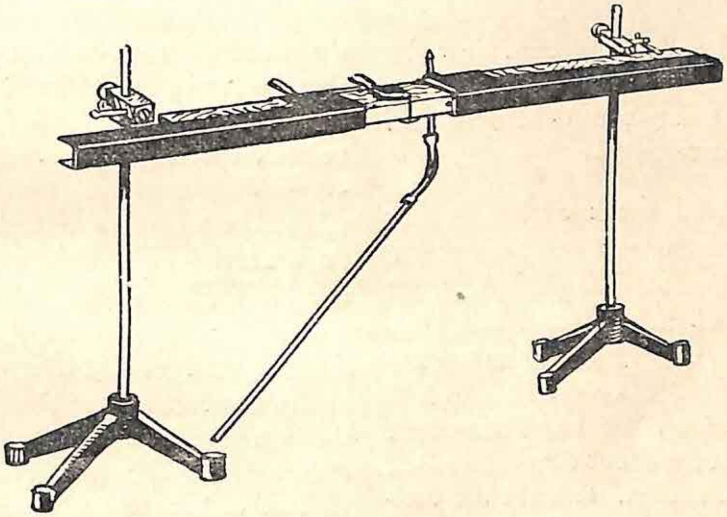

Fig. 7. Galton bar.
(Manufactured by C. H. Stoelting Co., Chicago.)

PROCEDURE:

The experiment is divided into 4 parts, each part comprising of at least 20 readings. In the first part, the standard is kept to the subject's right side, in the second and third parts to the left, and right again in the last part. This is done to determine the 'space error' as well as to counterbalance the 'practice effect' emerging in the experiment with the successive trials. There will be a 'space error' in this experiment because the standard and the variable lines cannot be simultaneously in the same place. The assumption, on which this couterbalancing method of '*abba* (Here *RLLR*) order is based, is that the progressive errors on response may take place almost in a straight line as experimentation proceeds.

Part 1.

1. The Galton bar, 100 cms. long, is adjusted with clamps on a table with the help of two stands at a distance of 100 cms. from the 'S', which is kept constant throughout the whole experiment. The level of the Galton bar is kept parallel to the ground with the help of the spirit level. The height of the Galton bar is kept in the level of the subject's eye and its centre (marked by a straight vertical line at 50 cms.) just in front of the subject.
2. The standard length of 20 cms. is set by keeping the standard pointer at 30 cms. and throughout this part of the experiment, it is kept at that position.
3. Before each trial the movable pointer (variable) is placed at a point either too shorter than the standard or too longer than the standard. In the total 20 readings of this part of the experiment, they are distributed in a random order. Thus in 50% of the observations, the movable pointer can be placed at near about 5cms. and in the rest 50% at about 45 cms., to make the variable line too longer and too shorter respectively. When the variable is set too shorter than the standard, 'S' moves its pointer outward to adjust, while he moves it inward when the variable is too longer.
4. The 'S' is given the following instruction for the first and last parts of the experiment:—

   "Please see the length marked by the pointer at the right of the Galton bar. This is the 'standard' length. You have to adjust a 'variable' (movable) line at its left apparently equal to it. Move the pointer of the variable line until you are satisfied that the same length is adjusted at the left of the Galton bar as that of the 'standard' line. When you feel satisfied that you have finished the adjustment, tell me."
5. After the adjustment, the exact length of the variable is measured (without S's knowledge) from the scale drawn on the back of the Galton bar and the error is recorded in millimeters. The direction of the error is also recorded with positive or negative signs. The experimenter ('E') also keeps into the record before each trial whether the variable was kept too shorter or too longer. This is done to determine the extent of 'Movement error'.

Part 2 and Part 3.

The procedure here is exactly the same as the preceding part with the only exception that the 'standard' length is now kept at the subject's left side by setting the standard pointer, at about 70 cms. and this is kept till 40 readings are taken for the two parts. The subject is asked to adjust the variable line now at the right of the standard apparently equal to the latter.

The pointer of the variable is now placed at about 55 cms. for 50% of the observations and in the rest 50% at near about 95 cms., to make the variable line too shorter and too longer respectively. The setting of the variable 'too shorter' or 'too longer' than the 'standard' is done in a random fashion and their sequences are noted in the record. The exact measurement of the adjusted variable is recorded after each trial without S's knowledge as before and the direction and extent of error is also taken into account.

Part 4.

In the final part of the experiment, 20 readings are again taken just in the way already stated for Part 1. This is simply a repetition of the first part.

RESULTS:

The raw data is tabulated in the manner given below and the direction and extent of the errors are graphically presented.

Part One.	Standard at Right.				Part Two.	Standard at Left.			
	Variable too Shorter.		Variable too Longer.			Variable too Shorter.		Variable too Longer.	
Trials.	Length of Variable adjusted	Extent & Direction of Error	Length of Variable adjusted.	Extent & Direction of Error.	Trials.	Length of Variable adjusted	Extent & Direction of Error	Length of Variable adjusted.	Extent & Direction of Error.
1					1				
2					2				
3					3				
4					4				
5					5				
6					6				
7					7				
8					8				
9					9				
10					10				
Average					Average				
PartFour	Variable too Shorter		Variable too Longer		Part Three	Variable too Shorter		Variable too Longer	
Trials	Length of Variable adjusted	Extent & Direction of Error	Length of Variable adjusted	Extent & Direction of Error	Trials	Length of Variable adjusted	Extent & Direction of Error	Length of Variable adjusted	Extent & Direction of Error
1					1				
2					2				
3					3				
4					4				
5					5				
6					6				
7					7				
8					8				
9					9				
10					10				
Average					Average.				

From the tabulated data the following statistics are calculated :—

1. Average Error (Mean of the Errors neglecting Algebraic Signs) of the total 80 trials.
2. Average Error of the 20 trials for each of the parts.
3. Constant Error (Mean of the Errors with Algebraic Signs) of the total 80 trials.

4. Constant Error of the 20 trials for each of the parts.
5. Constant Error of the 40 trials for each of the conditions—Standard at Right & Standard at Left.
6. Space Error (Difference of the Constant Errors of the two conditions).
7. Constant Error of the 40 trials with variable too shorter.
8. Constant Error of the 40 trials with variable too longer.
9. Movement Error (Difference between the two Constant Errors found in 7 and 8)
10. Variable Error (S. D.) of the length of 'variable' adjusted for all the 80 trials.
11. Probable Error = 0·6745 of the S. D.

The above statistics should be presented in a tabular form.

DISCUSSIONS:

The following questions should be answered :—

1. Describe whether the 'S' underestimated or overestimated in adjusting the 'variable' line with the 'standard'? (Hints :—If the C. E. of the total trials is of negative value, it shows underestimation; if positive, overestimation) What is the 'Point of Subjective Equality' for him?
2. What is the nature and amount of the Space Error and Movement error?
3. From the Probable Error calculated, say how well is the S's discrimination. (Hints:—D.L. may be regarded as directly proportional to the P. E.). Do you regard your result in any sense a verification of Weber's law? Explain. Suggest any other way to verify Weber's law in the perception of visual extent.
4. From the graphical representation of the extent and direction of error for all the 80 trials and from the Average Error and Constant Error of each part, describe the effect of practice and fatigue and discuss how far they are counterbalanced.
5. What are the defects noticed by you in this Psychophysical method?

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EXPERIMENT 10

R. L. For Grey (The method of limits)

INTRODUCTION:

The term 'limen' first introduced by Herbert (1811) in Psychology means threshold or transition point. The abbreviation R. L. denotes 'Reisen Limen'. The German equivalent for 'Stimulus' is 'Reisen'. Thus 'Stimulus limen' means the magnitude of stimulus that just brings a sensation to consciousness. R.L. should not be confused with the term D. L. which means the magnitude of stimulus that corresponds to a minimum increase of stimulus so as to bring a 'just noticeable difference' in the same sense continuum. Thus whereas " stimulus threshold (R. L.) is the transition point between stimuli too weak to elicit a response and stimuli strong enough to elicit that response, the difference threshold (D. L.) is the transition point between differences too small and those large enough to be perceived."

The stimulus threshold is illustrated by the watch test for hearing. If a watch is kept very close to the ear and then gradually carried away at a slow uniform speed to a certain distance, it ceases to be heard. The distance up to which the watch is found ticking and the distance beyond which it ceases to be heard is the transition point. The distance marks the R. L. for that stimulus.

The commonly used Psychophysical method for determining R. L. is the method of limits. In order to determine the R. L. for any stimulus, we begin with a stimulus which yields a clearly noticeable sensation and reduces its intensity by small and regular gradations, until the sensation is no longer felt. Or, we may begin with a stimulus magnitude which is so small that it is not perceived by the 'S' and then increase it by steps till he perceives it. The former is called 'descending series' and the latter is called 'ascending series'. A number of series are taken, once in descending and once in ascending order. The stimulus value which has a probability of producing sensation 50 per cent of the times, is taken as the R. L.. Above the R. L., stimuli yield a response more than half the time and below it, they elicit a response less than half the time.

The present experiment uses the method of limits (or minimal changes) in determining the R. L. for grey.

MATERIALS:

1. Two discs, one black and one white of equal size.
2. A Grey Cardboard.
3. A Colour Wheel. (Fig. 8)
4. A Protractor.

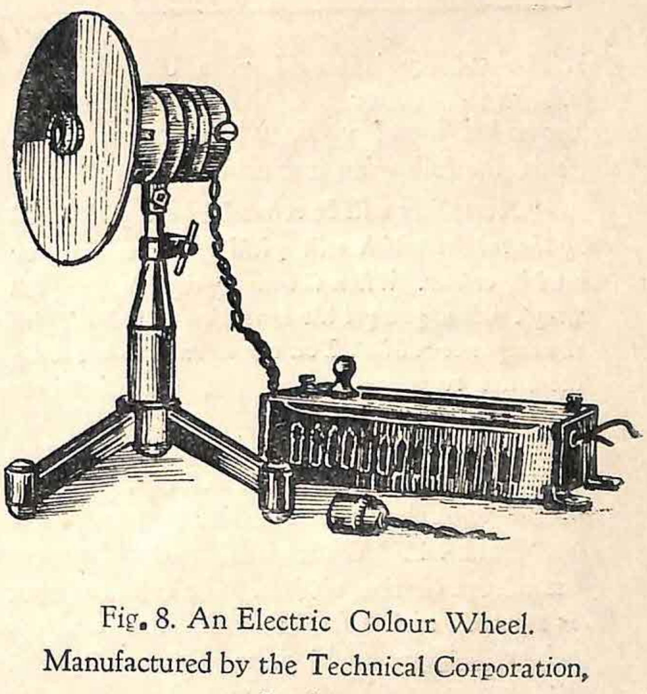

Fig. 8. An Electric Colour Wheel.
Manufactured by the Technical Corporation, Lucknow.

R. L. FOR GREY (THE METHOD OF LIMITS) EXPERIMENT 10

PROCEDURE:

1. The colour rotator (colour wheel) is set up in good illumination which can be kept constant throughout the observation. The grey cardboard is placed behind the rotator so as to check retinal after-sensation.

2. The Experimenter (.E) prepares a chart like the following before the experiment starts.

Stimulus Value	Series										Rest 5 Minutes.	Series									
(Proportion of Black)	d	a	d	a	d	a	d	a	d	a		d		d	a	d	a	d	a	d	a
190°																					
185°																					
180°																					
175°																					
170°																					
165°																					
160°																					
155°																					
150°																					

3. The subject is seated at a distance of 4 ft. from the rotator and the discs are placed just on his line of vision when rotating. He is given the following instruction:—

"Some discs will be rotated at a rapid speed by the rotator which will yield either a grey or a white colour. When it seems 'grey' to you, tell 'grey', when you get the sensation of 'white', give the response 'white'. You are allowed to use only these two responses."

4. The colour rotator is moved towards the experimenter and the black disc is interlocked with the white one and proportions of 190° Black + 170° White is adjusted without the knowledge of the subject. The colour rotator is rotated and then moved towards the subject. The subject is given 5 Secs. (approximately) to see and then judgment is asked from him which is recorded in the chart prepared.

5. The rotator is stopped and now 185° Black + 175° White is adjusted, before the rotator is started again. The subject's response is again recorded. In this way the proportion of black is lessened by 5° each time and consequently an increase of 5° in the proportion of white takes place before each trial, till the descending series is finished with the subject reporting 'white'.

6. The ascending series starts with 160°Black +200°White and in each step an increase of 5° in the proportion of Black is made till the series is finished at that point where the judgment of 'grey' is first reported.

7. In this way a descending order, followed by an ascending order, is taken till 5 descending and 5 ascending series are finished.

It is noted that the subject gets neither the knowledge of the proportions of stimuli interlocked in the disc and adjusted before each trial, nor the direction of the adjustment—whether an ascending or a descending order will follow.

8. Now a rest pause of 5 mts. is given after which the experiment is again started with an ascending series. The procedure is the same as before and 5 ascending series and 5 descending series are taken, each time an ascending series followed by a descending one.

RESULTS:

From the judgment of the subject recorded in the chart, the transition point for each descending series is found by taking the average of the last value where the subject reports 'grey' and the first value where he gives the response 'white'. The transition point for each ascending series is found by averaging the last value at which the subject gives the response 'white' and the first value where he says 'grey'. The transition points for the successive series may be joined by a straight line in the chart for the sake of clarity. The average of the different transition points found for the whole experiment gives the required R.L. The R.L. for part 1 and part 2 of the experiment may similarly be calculated. The R. L. for the total ascending series and R. L. for the total descending series may also be calculated and the results are tabulated in the following order:—

R. L. for the total experiment.
R. L. for the first half of the experiment.
R. L. for the last half of the experiment.
R. L. for the ascending series.
R. L. for the descending series.

DISCUSSIONS:

From the results obtained, the following questions should be answered:—

1. What is the obtained R. L. for the whole experiment ? How do you interpret it ?
2. From the results determine the relative effects of the factors of habituation and expectation. (Hints—R. L. for ascending Series and R. L. for descending Series should be compared).
3. Is there any practice effect apparent in the successive series ? Has there been any progressive change in the limen during the whole course of the experiment ? (Hints—Compare the R. L. for the first half of the experiment with the R. L for the last half).
4. What are the defects of the method of limits ? Discuss with reference to the results obtained. What modifications can you suggest to eliminate them ?

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EXPERIMENT 11

R. L. For Two Point Sensation (The Constant method)

INTRODUCTION :

(When two points are simultaneously stimulated on the skin they are felt as one point unless the two points are separated by a sufficient distance. The liminal value of the separation between them is known as the two point threshold or 'Spatial threshold'. It is also known as the 'Esthesiometric index', because it is usually determined with the help of the instrument known as Esthesiometer.)

The change of one point sensation to two point sensation is generally studied by the 'method of limits'. But several flaws have been found with this psychophysical method. Among these, 'expectancy error' and 'habitual error' are most commonly noted. These errors arise from the progressive nature of the method of limits. In an ascending series the subject knows that the intensity of the stimulus (for R. L.) or the magnitude of the difference (for D. L) is increasing. Expectation of the point at which he will cease to experience the sensation or notice the difference may lead him to anticipate this point. Analogous conditions are of course present in the descend ing order. On the other hand, the subject may become accustomed, or habituated, or accommodated to a certain form of judgement and the point at which the judgement should change may thus be postponed. In an experiment on esthesiometric index, he may, for example, become habituated to say 'one point' where he should have said 'two'. As in the case of practice and fatigue, expectation and habituation will tend to counteract one another but we cannot assume that they will balance one another.

So in order to meet these difficulties the graded series of the method of limits is made haphazard. Thus this method makes 'with knowledge' procedure of the method of limits 'without knowledge.' Though this method of 'without knowledge' as termed by Guilford, is taken as a modification of the method of limits, it is essentially a 'constant method'. The attitude of the subject is radically altered 'with this method and so it is very doubtful whether the results obtained by the method of limits, are really comparable with the results obtained by the constant method.

In this constant method (Also known as 'Method of right and wrong cases'), the threshold is first roughly determined by the method of limits. Then the values taken round the transition point are presented one by one in a random order, although retaining the serial arrangement of the record made for the method of limits. The percentage of right and wrong answers (in experiment on 'Spatial threshold' the percentage of two point answers) is calculated for each stimulus value and by using statistical method based on the theory of probability the R. L. is found out.

The present experiment makes use of the constant method in determining the R.I. for two point sensation, on the volar surface of the subject's right forearm.

MATERIALS:

1 A Jastrow's modified Esthesiometer (Fig. 9)
2. A cotton pad on which the S's hand should rest.
3. A safety razor.
4. Blindfold.

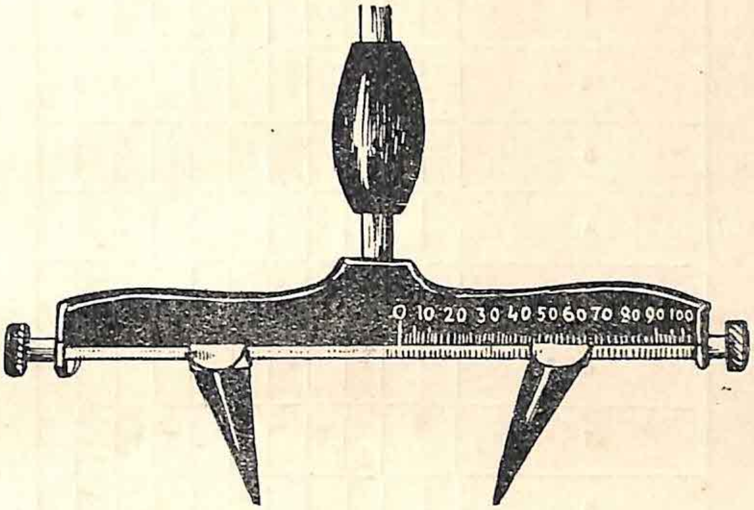

Fig. 9 Esthesiometer
(Manufactured by C. H. Stoelting & Co., Chicago)

PROCEDURE:

1. The experimental area (volar surface of the forearm) is cleanly shaved and a line of 4″ drawn on it by ink. The S's arm is kept on the cotton pad.

2. The 'S' is blindfolded and instructed as follows:—

   "I am going to touch your forearm with a blunt thing which will not hurt you in any way. Please report whether you feel one or two points on the skin after the touch."

3. Starting with a 'supraliminal' distance, say 80 mm. with a gradation of 2 mm., the transition zone (not point) is approximately determined after 4 ascending and 4 descending series are completed on the line drawn on the experimental area. 5 stimulus values above and below the rough transition point, subsequently calculated by the mothod of limits, (see Experiment 10) are presented in a haphazard order to the subject, the stimulus values being adjusted each time in the mm. scale of the esthesiometer. The S's report taken after each stimulation, is recorded. 10 readings are taken for each stimulus value with a rest pause of 2 seconds after each 5 readings.

The following precautions should be taken in conducting the experiment:—

(a) The subject should not be given to guess that one or two points will be stimulated.

(b) Any kind of fatigue on the skin area experimented should be avoided.

(c) Great care should be taken to apply and to withdraw the two points immediately. The esthesiometer shouldn't be pressed hard on the skin; a clearly defined sensation of contact is all that is necessary.

RESULTS :

The raw data of the subject's judgement of one or two points is entered into a table like the following:—

Trials	Stimulus values in mm.										
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
Percentage of 'two point' answers.											

After the percentages of 'two point' answers for different stimulus values have been computed, the R. L. is roughly determined by the following formula* given by Myers (first suggested by Titchener).

$$D = \frac{D\alpha\ (\beta-50)+D\beta\ (50-\alpha)}{\beta-\alpha}$$

where D = Spatial threshold (Distance)

$D\alpha$ = Distance (stimulus value) where less than 50% of two point answers are obtained.

$D\beta$ = Distance where the two point answers are just above 50% of the times.

α = percentage less than 50.

β = percentage more than 50.

DISCUSSIONS :

The following questions should be discussed:—

1. What is the R.L. obtained in the present experiment ? Is the R. L. thus determined a more correct value than the R. L. computed by taking averages of the different transition points of ascending and descending orders obtained by the Method of limits ? Can the same treatment be possible with the data obtained in the present experiment ? If so, see how the R. L. thus calculated tallies with the one calculated by Myer's formula.
2. What interpretation can you make of the R. L. obtained in the present experiment ?

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* From C. S. Myers, *Text book of Experimental Psychology* Vol. 2, p. 218

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3. Are the same cues helping in the perception of two points as those which help in the localisation of a single point ? Describe how the two problems are inter-related .

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EXPERIMENT 12

Study of Colour Preferences

INTRODUCTION:

A person not only perceives the colour of an object of art, clothing or landscapes, but also responds to it affectively. In some degree he likes or dislikes the colours. This is true both for single colour in isolation and for two or more colours together. Thus every colour arouses what is technically termed as 'feeling tone of sensation'.

Experimentation has demonstrated that feeling tone depends upon 3 attributes of colour. They are (1) Hues, (2) Saturation, and (3) Brightness. Some hues are preferred over others. Red and blue are ranked as preferred hues. A yellowish green usually has a low preference value. Rich or saturated colours are liked better than colours of low saturation. Thus a very saturated red is preferred over a grayish or weak red. Bright colours are liked better than dull colours. Scarlet, for instance, is preferred over a brownish or 'washed out' red.

Although colour preferences are found relatively stable when the rank order of preference from one group is compared with rank order from another group, there are great individual differences. One person may like green very much while another dislikes it. When colour combinations are investigated, an even greater individual variation in the preference is found.

In the present experiment the method of paired comparison will be employed to present the Colour to the subject.

This method may be employed in any situation where the relative values of stimuli in a series are desired, provided all stimuli possess a quality upon which comparative judgements can be made.

The purpose of the present experiment is to measure, by the Method of Paired Comparison, preferences for seven spectral colours.

In the paired comparison method employed for presenting simultaneously the stimulus cards, each coloured stimulus is compared with all other stimuli in each part of the experiment. Two Cards are presented to the subject side by side and a preference is called for. The number of presentation is the amount obtained from the formula $\frac{N(N-1)}{2}$ where N = the number of Cards in the series. In the present experiment it should have been $\frac{7(7-1)}{2} = 21$. But in this experiment the series is repeated in reverse order as well as in the forward order to ensure adequate controls. When presented in pairs, a colour may have an undue advantage if it always appears at the right or always at the left. This brings a 'Space error' which complicates the judgement. In order to cancel out this 'Space error', each pair of stimuli should be presented twice with the right and left colours reversed when going through the series the second time. A convenient form for recording the preference is to use the so called 'L' table.

During the first series of comparisons, entries are made in the lower half of the table. When the comparisons are repeated the entries are made in the upper half. To summarise the comparisons, the table is treated as a whole and the totals obtained give the number of times each colour was preferred.

MATERIALS:

1. A gray cardboard 10 × 16 inches, with two apertures, each 2 × 3 inches, lying 1 inch

Colour Number	1	2	3	4	5	6	7	
Columns	Red	Orange	Yellow	Green	Blue	Indigo	Violet	Total
R 1	■	21	19	16	12	7	1	
O 2	1	■	20	17	13	8	2	
Y 3	7	2	■	18	14	9	3	
G 4	12	8	3	■	15	10	4	
B 5	16	13	9	4	■	11	5	
I 6	19	17	14	10	5	■	6	
V 7	21	20	18	15	11	6	■	

('L' table showing the sequence of trials with number)

apart from each other in the middle of the cardboard. Behind the apertures, arrangement is made to hold colour cards of 2·5 × 3·5 inches.

2. 7 Cards of 2·5 × 3·5 inches of red, blue, yellow, green, orange, violet and indigo colours, each card being numbered at its back so that preference may be indicated by number rather than by colour.

PROCEDURE :

1. According to the given table the colour cards of red and orange are inserted in the aperture in the first trial, the orange card at the right of the subject and the red at the left. The colours are exposed, simultaneously, for a period of 3 seconds and the subject is asked to say which one is liked. If red, 1 is then written in the orange column of the lower half of the table; if orange, 2 at the same place.
2. In this way red is compared with yellow (in the 7th. trial) keeping yellow at the right. The response is noted in the same way. Thus each colour appearing with every other colour is presented with the colours of larger number assigned, keeping it always at the right during the first half of the experiment and when the pairs are presented the second time, the larger number is always kept at the left. The trials follow each other in sequences as indicated by the number from 1 to 21 in the given table for both the sessions.

RESULTS :

The total number of times each colour preferred is counted and written in the last column of the 'L' table. From this, the rank is given. (For detailed treatment of the data, See Woodworth & Scholosberg's *Experimental psychology* (1954). A bar diagram is made indicating the rank of the colours from the most preferred to the least preferred.

DISCUSSIONS :

The following questions should be discussed—

1. How far do your results support Von Allesch's conclusion, "No colour is beautiful, none ugly, but any colour can be either at a given moment or in a given place' ?
2. Suggest the principal ways in which preferences develop. How could you make a

child prefer one colour rather than another?

3. What practical implication this study under "Experimental Esthetics" has ?

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EXPERIMENT 13

Perception of Filled & Unfilled Time Interval

INTRODUCTION :

One of the early topics to receive experimental study in the field of time estimation was the effect of filled and unfilled time. Filled temporal interval is the interval between two stimuli which is occupied by the same stimuli or by some other stimuli. It is a continuous duration. Unfilled time is the duration bounded by two stimuli which mark its beginning and an end. Interval of the second kind, those marked off by taps or flashes of light, are technically called 'Empty time'. (No interval, however, can be perceived empty. There is always organic changes going on in the living organism and various organic rhythms, which may constitute the basis of our estimation of the duration.)

Although the literature of this topic of filled and empty interval is extensive, the results are by no means consistent. However, many writers are still of the opinion that a filled interval is generally perceived longer than an empty interval of the same length.

The present experiment seeks to test the above hypothesis with auditory stimulus.

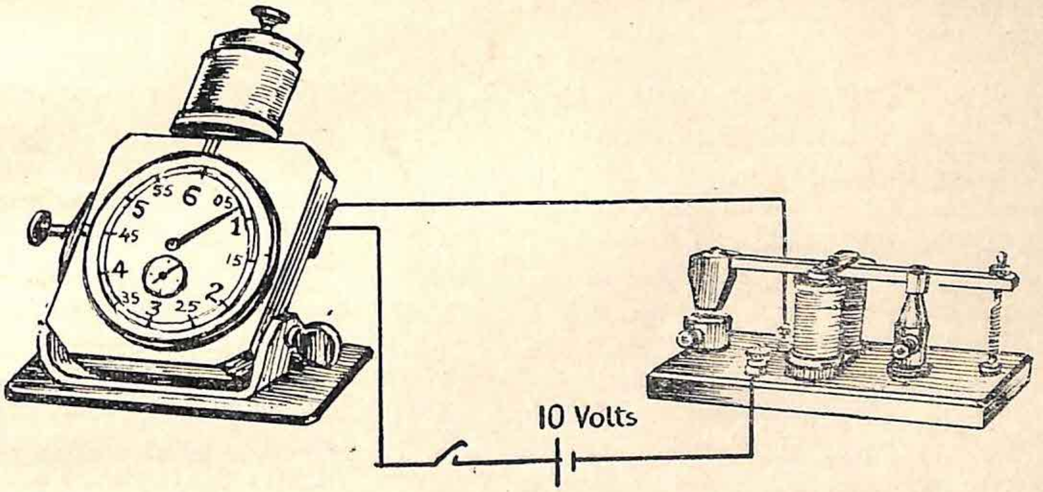

Fig. 10. Sound hammer connected with Stop watch.

MATERIALS:

1. Electromagnetic Sound Hammer
2. Time wheel (if not available, an Electric Stop Watch as that shown in Fig. 10 will do).
3. Make key.
4. A 10-Volt Battery and Wires.
5. Electric Bell.

PROCEDURE

The psychophysical method of constant stimulus difference (See Experiment 8) is used in this study. The experiment is divided into two parts. The first part deals with the determination of D. L. for empty interval and the second, with the filled one.

Part 1:

1. The Electric Stop Watch is connected as in the figure 10, if Time wheel is not available. The moment the key is pressed, the stop watch starts and its hands go on moving even if the circuit is broken by the release of the key. It stops only when the Key is pressed once again. So in order to mark

an empty interval of a definite period, one must press the Key, then release it and press it once again when the interval is just to be over. By this operation, the sound hammer will also sound twice, once giving the beginning of the interval and another its end.

2. Before the experiment starts, 'E' prepares a table (without the knowledge of 'S') keeping in mind that the 'standard' duration of 3 seconds is presented before the variable stimuli (1, 2, 3, 4 and 5 seconds) in half of the times and in half it is given after the variable stimuli. The presentation of the standard duration should be so random that no guessing is possible.

3. Before the experiment, 'S' is instructed as follows :-

> *"You are to hear attentively a time interval bounded by two successive clicks of the sound hammer. After a fixed duration, a temporal interval marked in the same way will be presented. You are to compare the second duration with the first one and to say whether it is 'greater' or 'lesser' than the first or 'equal' to it. Before each trial you will be given a 'ready' signal.*

4. 'E' gives the 'ready' signal and presses the key, releases it and again presses it before the period (as scheduled in the prepared table) is just to be over. After 2 seconds he does the same operation to mark the beginning and end of another time interval— variable or standard. The subject is then asked for his judgement and it is noted by suitable symbols. In this way each of the variable stimuli is presented 5 times before the standard duration of 3 secs. and 5 times after it. This will give a total of 50 readings. A rest pause may be given after each 10 readings.

5. After all the 50 readings are taken, a rest pause of 20 mts. is given which enables 'E' to prepare for the second part of the study. A similar table used in the first part is made for this part of the experiment without the knowledge of 'S'.

Part 2:

1. The Sound hammer is taken out and an electric buzzer is connected instead.

2. 'S' is instructed as follows :-

> *"In this part of the experiment you are to hear attentively two continuous sounds presented one after another, interspersed by a fixed duration. Observe whether the second sound continues 'more' or 'less' than the first sound. You have to judge whether the second is 'bigger', 'smaller' or 'equal' to the first one. Every trial will be followed by a 'ready' signal".*

3. The 'ready' signal is given and then the key is pressed for a period as scheduled. Just after 2 secs. another continuous interval is marked by pressing the key for a scheduled period. Each interval is measured by noting the stop watch and 'E' should try utmost to produce a continuous sound just for a period as scheduled in the prepared table—not a second less or more than that. He should try to check his own reaction-time being measured in the stopwatch. For this accuracy, some practice is needed.

4. The subject gives after each trial his judgement of the first interval in terms of the second and it is noted every time. 50 trials are given with a rest pause of 2 mts. after each 10 trials.

RESULTS :

The principal result is shown in a table like the following in which the proportions of judgement of 'Greater', 'Equal', and 'Lesser' are given for every variable stimuli, both filled and unfilled.

The table is also graphically presented as in the experiment on lifted weights. The three responses given for filled interval are shown with continuous lines and the responses for unfilled interval with broken lines.

Variable stimulus value	Proportions of the three responses					
	Gr. filled.	Gr. Unfilled	Eql. filled	Eql. Unfilled	Lr. filled	Lr. Unfilled
1 Secd.						
2 Secds.						
3 Secds.						
4 Secds.						
5 Secds.						

From the table, the following are computed by 'the summation method' already described.

1. D. L. for filled and unfilled intervals.
2. Constant Errors for the same.

From the Constant Errors, it can be directly found whether the subject overestimated or underestimated and then the relative difference between the two parts of the experiment is determined.

DISCUSSIONS :

The following questions should be answered :—

1. Does the hypothesis with which you started appear to be verified ? If it is not proved, state what are the subjective factors that can be ascribed for this inconsistency ?
2. Does your study throw any light on the theories of temporal perception ?

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(A detailed review of the Studies in filled and unfilled time intervals).

EXPERIMENT 14

Fluctuation of Reversible Figure as a Function of Mental Set

INTRODUCTION :

Somewhat related to the problem of fluctuation of attention is the fluctuation of reversible figures. If one observes the ambiguous figures of Rubin, he will find how unstable they are. They are seen clearly and satisfactorily in a given aspect at one moment, but all at once they suddenly lop over and present a radically different relief. At one moment, for example, the black figure is seen as though on a white background; the next moment the white figure as on a black background.

With no specific instruction to the subject as such, it has been found that a geometrical figure with an ambiguous perspective fluctuates at seemingly regular intervals, alternating between the concave and the convex. But this regularity is broken by the attitude of the subject. If the subject is instructed to hold any of the figures the stability for any of the figures becomes greater. The figure will change despite his effort to hold it; but it will very likely change less often. Similarly if the subject is instructed to hasten the fluctuation, the fluctuation is accelerated.

Thus all other conditions being equal, the rate of fluctuation of reversible figure is a function of the mental attitude of the observer. This experiment tests the above hypothesis.

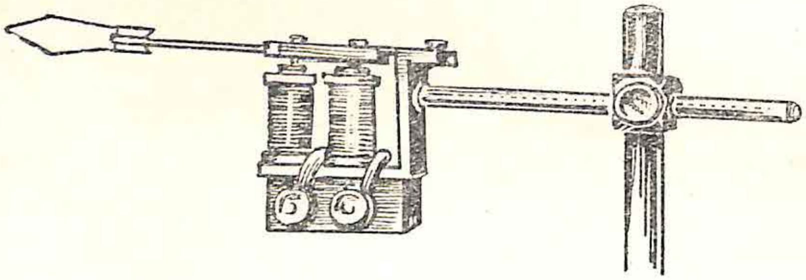

Fig. 11 Electromagnetic Stylus.
(Manufactured by The Technical Corporation, Lucknow)

MATERIALS :

1. Any ambiguous figure made after Rubin.
2. Kymograph and accessories.
3. Electromagnetic stylus. (Fig. 11)
4. Chronometer.
5. A simple key.
6. Smoking accessories.
7. Dry Cell Batteries (2 volts).

PROCEDURE:

Part 1. (Normal Rate of Fluctuation)

1. The Card containing the reversible configuration is placed on the line of the subject's vision at a distance of about 2 feet from him.
2. The glazed paper on the Kymograph drum is smoked and the necessary connections made in the way stated in the experiment on fluctuation of attention (Expt. No. 18).
3. The levers of the Chronometer and the stylus are fixed on the stand and so adjusted that they touch the smoked drum lightly.
4. The recording drum is moved at the rate of about 1 revolution per 3 minutes.

5. Then the subject is seated comfortably before the figure and instructed as follows:—

   "With the 'Ready' Signal, please fix your eyes on the centre of the figure. As you fixate you will notice that the white sectors stand out upon a black background at one moment while the black sectors stand out upon a white background at the next. When the white figure comes out, press the key and hold it down; release the key when the black figure appears."

6. The experiment is then started and continued for 2 minutes. 'E' marks on the smoked paper whether upper tracing or lower tracing recorded by the time marker indicates the presence of a particular relief of the ambiguous figure to the 'S'.

7. A rest pause of 5 minutes is given to 'S' to dissipate his retinal fatigue and then Part 2 of the experiment is started.

Part 2. (Slowest Rate of Fluctuation)

1. The drum is pushed upward to take another record after 2 minutes.

The other procedures are the same as before with the exception that the subject is now instructed here to slow down the fluctuation as much as possible by holding each phase just as long as he can.

The subject has to maintain fixation with the above instruction for 2 minutes.

Part 3. (Fastest Rate of Fluctuation)

The procedure here is the same as before except that the subject is instructed to make shifts come more rapidly by expecting the next change the moment one has occurred.

Readings are taken for another 2 minutes.

RESULTS :

From the kymograph record, the total and the average length of time during which the white figure and also the black figure appeared is determined. This is done for all the three parts of the experiment so that the results for the various parts may be compared. The net results for the three conditions may be tabulated as follows :—

Conditions	Total reversals	Number of times white figure appeared	Number of times black figure appeared	Average duration the white figure appeared	Average duration the black figure appeared
Normal					
Retarded					
Speeded					

DISCUSSIONS:

The following questions should be discussed:—

1. How does mental set influence the rate of fluctuation ? How successful was the subject in controlling the fluctuation rate ? Was there any evidence of improvement in the control due to practice ? Could the subject probably learn to stop the fluctuations entirely or to make the shifts too rapid to count ?

2. Was there any rhythmical fluctuation of the figure-ground relationship ? What might the finding of a rhythmical fluctuation imply regarding the controlling factors in the phenomenon ?

3. What explanations have been offered to explain this phenomenon of fluctuation ? What theory is supported by the factors (observed by you during observation) which are probably influencing the reversals ?

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EXPERIMENT 15

Demonstration of Brightness Constancy

INTRODUCTION:

Objects vary very much less in their forms and appearances than do their corresponding images on the retina. The size of a near circle equated to a distant circle is usually much nearer the 'real size' of the distant circle than, it would be if determined by the relative sizes of the retinal images. If we inspect two pennies one at a distance of three feet and the other twice as far away, the nearer penny does not look anything as twice as big as the farther one. Similar considerations apply to visual perception of shape, brightness and colour.

Many psychologists have taken an interest with these constancy phenomena which have now been put under one comprehensive term "phenomenal regression to the real object" by Thouless. "The regression, or approximation, is from the stimulus colour, size or shape towards the object colour, size or shape," but the actual impression, i. e. the apparent phenomenal colour, size or shape, usually happens to be intermediate between these two 'poles.' [Brunswick, (1934) reviewed by Ansbacher. (1937)].

As an example of brightness constancy, we know that coal still looks black in sunlight and a white paper white even in shadow. If brightness were determined exclusively by the amount of white light which an object reflects to the eye, the coal under the condition should have appeared to be very much brighter than the paper under shadow.

The present experiment demonstrates the phenomenon of brightness constancy under laboratory conditions.

MATERIALS:

1. A colour mixer mounted on which are two discs—one white and one black.
2. A cardboard screen of neutral gray, large enough to conceal the mixer.
3. Another similar screen with an aperture (diameter 3 cms.) near the centre so that, when the screen is set up 50 cms., in front of the mixer and the aperture at the height of the subject's eyes, he can see only an area of the mixture disc and the knob of the mixer. Neither the edge of the disc nor the shadow of the knob should be visible. This screen is referred to as the 'reduction screen'.
4. A piece of neutral gray cardboard of such a size, when fitted to the side of the mixer, will cast a visible shadow larger than the disc. This screen is referred to as the 'shadow caster.'
5. A book of 30 Hering's gray paper of known stimulus value in terms of mixture of black and white (To be had from C. H. Stoelting & Co.)
6. A protractor.

PROCEDURE:

1. The subject is seated near the window with one side of his face turned to it.
2. The mixer is set up about 1 meter (100 cms.) in front of the subject and far from the window. The reduction screen is placed at 50 cms. in front of the mixer and the shadow caster fitted near the window at right angle to the side of the mixer. The window is opened in such a way that it will just leave the disc unshadowed by it. The

experiment succeeds excellently in a dark room with a lateral light source.

3. On the white disc, angles of 300°, 240°, 180°, 120°, and 60° are marked.
4. The black and white sectors of the colour mixer are adjusted to one of the above amount of white, chosen at random.
5. The book of Hering's gray paper is furnished to 'S' and the following instructions are given :—

   "At the signal 'now', look through the hole of the screen. Match what you see there with one of the papers in the book and record the number of the paper. Do not keep your eyes on the hole all the time. If you do not find an exact match, report the nearest match."
6. With shadow caster and reduction screen, the subject matches the gray paper with white value of 360°, 300°, 240°, 180°, 120° and 60° in the interlocking of black and white sector. (Instead of matching with the grays in the book, one may make the matches on another colour mixer, as was done by Katz. But it takes much more time.)
7. The reduction screen is replaced by the unholed screen and the whole experiment is repeated with a different haphazard sequence of the same black-white combinations. At the signal 'now' the screen is removed leaving the shadowed mixture freely exposed and the subject records his match for this series of the experiment.
8. The shadow caster is then removed and the experiment is repeated in the above way.

RESULTS:

The stimulus values of the gray papers matched are entered in the first three columns of the following table.* The other three columns headed 'Effects' are filled in as indicated. By subtracting the numbers in column 1 from those in column 3, the shadow effect (column 4) is determined which indicates reduction in stimulus-value produced by the shadow-caster. The canstancy effect (column 5) is similarly determined by subtracting column 2 from column 1. Finally, by subtracting column 2 from column 3 we can determine how far the constancy effect so found, departed from the perfect constancy.

	Matches			Effects		
	1	2	3	4	5	6
White-value of mixture	Stimulus-value of shadowed surface (with Reduction Screen)	Constancy-value of shadowed surface (without Reduction Screen)	Value of unshadowed surface (without shadow caster)	Shadow Effect (Col. 3 - col. 1)	Constancy Effect (Col. 1 - col 2)	Departure from Perfect Constancy (Col. 3 - col. 2)
360°						
300°						
240°						
180°						
120°						
60°						

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* Reproduced from Boring, Langfeld & Weld's *A Manual of Psychological Experiments* ,(1937) Page 91. By Permission of John Wiley & Sons, Inc., New York.

DISCUSSIONS:

The questions to be answered here are:—

1. How do you think that the phenomenon of Brightness Constancy was demonstrated by you ? Was the shadowed surface viewed alike with and without the 'Reduction screen' ?

2. If so, for which stimulus value it was more alike ? Did you find any relationship between the brightness of the stimulus value and the constancy effect ?

3. What light does the constancy phenomenon throw on the nature of perceptual process ? What are the other phenomena that illustrate the fact that what we perceive does not always correspond with what is before us ?

4. How is the phenomenon explained ? Is the perception of the shadow responsible for the Brightness Constancy ? What explanations has the Gestalt school offered ?

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5. Boring, Langfeld & Weld—*Psychology*. Pp. 275-286.

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EXPERIMENT 16

The Effect of Practice in Müller-Lyer Illusion

INTRODUCTION :

The Gestaltists thought they were getting another support to their theory that perceptual organisation is independent of past experience when Müller-Lyer Illusion was reported by many experimenters to be unaffected by past experience. But that Müller-Lyer Illusion is also influenced by past experience as in other instances of perception was first demonstrated by Heymans (1896). The work on this line was ingeniously progressed when Judd (1905) made a systematic study of this practice effect. Judd was able to demonstrate the influence of past experience when the Müller-Lyer figure was presented in one constant position, without any right-left reversals. Müller-Lyer Illusion was almost overcome with this condition only after the subject made 600 settings, 25 per day. At the outset, the feather head (variable) line was adjusted 17% shorter than the arrow head (standard) but this percentage fell to 2% at the end of the practice. No practice effect was found when the arrow head was sometimes presented to the right of the featherhead and sometimes to its left. When the figure was reversed, the illusion returned to exaggerated form and was not overcome by further practice.

Lewis (1908) found another difficulty in demonstrating the effect of practice in Müller-Lyer Illusion. He found that if the Müller-Lyer figure was exposed for a very brief period to the subject in each trial, no practice effect could be found even if some 1000 trials were given. But the practice effect emerged in the Müller-Lyer Illusion only when the exposure of the figure was prolonged before each trial. With this condition, the illusion tended to disappear with continued practice, even though the subject remained unaware throughout the nature of the illusion.

Thus it seems that the practice effect in Müller-Lyer Illusion can be demonstrated if the figure is shown to the subject for a considerable period before each setting and in a constant position throughout the experiment. The present experiment aims to demonstrate the effect of practice by maintaining the above two conditions.

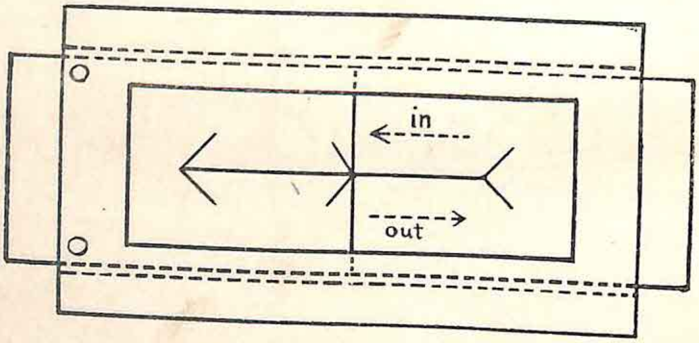

Fig. 12. Müller-Lyer Illusion card.

MATERIALS:

1. Müller-Lyer Illusion Card (figure 12)
2. A millimeter Scale.
3. A chin-rest.
4. Screen.

EXPERIMENT 16

PRACTICE IN MÜLLER-LYER ILLUSION

PROCEDURE:

1. The Müller-Lyer Illusion Card (the feather-head at the right) is set 1 ft. from the subject (the position remaining constant throughout the experiment) and is held just in line with his vision by adjusting the chin-rest at the proper height.
2. The subject is instructed as follows:—
   "I am going to show you a card with two lines side by side each demarcated by oblique lines. The left line bounded by the inward obliques is called the arrow-head line and the right line bounded by the outward obliques is called the feather-head line. You have to adjust the feather-head line each time equal to the arrow-head line by sliding the feather-head. Adjust it as accurately as you can. When you have adjusted, report."

Successive trials	Average Error in mms.	Percentage shorter than the standard.
First 10 trials		
Second 10 trials		
3rd. 10 trials		
4th. 10 trials		
....		
19th. 10 trials.		
Last 10 trials.		
Difference between Last & First 10 trials.		

3. The feather-head (variable) line is always presented smaller than the arrow-head line (standard) and thus the subject has always to move the variable line outward.
4. The subject is given time as long as he desires for the adjustment.
5. For each trial, the length of the adjusted line is recorded without the subject's knowledge from the opposite side of the card on which a scale is drawn.
6. 200 trials are thus taken successively and introspection from the subject is asked for after each 10 trials.

RESULTS:

The errors in equating the feather-head line to the arrow-head line are determined for each trial and the Average Error of judgment for each 10 trials is computed and tabulated as shown above.

The tabulated result should also be graphically presented with the successive 10 trials at the abscissa and the 'percentage shorter than the standard' at the ordinate. The 'practice effect' (percent gain) should finally be computed by the formula.

$$\frac{\text{A.E. for First 10 trials} - \text{A.E. for Last ten trials}}{\text{A.E. for First 10 trials}} \times 100$$

Where A.E. = Average Error.

DISCUSSIONS:

The following questions are to be answered:–

1. What is the 'percentage of gain' due to the practice effect ? From the graph, read how many trials were required to bring a significant fall in the error ?
2. What light does the demonstration of the practice effect in Müller-Lyer illusion throw on the theories of illusion ? Do you think that practice developed in your subject, the tendency to isolate the main lines and disregard the rest of the figure, thus bringing 'a part isolating attitude'? Do the introspective reports of your subject cast any light on this ? If the testimony of the subject supports the presence of 'a part isolating attitude' due to practice, do you think that the 'confusion theory' of Benussi is supported? Explain.

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EXPERIMENT 17

The Span of Apprehension as a function of 'Organisation'.

INTRODUCTION:

From our everyday experience we know that related materials are more easily grasped than words not familiar to us. It is about as easy to grasp one's full name as to grasp the initials, provided the name has come across several times in the past. The possibility of grasping facts (stimulus object) by large units increases with its meaning and organisation.

This is supported by experiments on the 'span of apprehension'. Letters, numerals, dots, lines etc. are shown in groups in exposures which are so short as to prevent eye movement. In such experiments it has been found that if the stimulus objects are united into larger units i.e. the letters are united into short words, one can grasp about three times as many letters when they form words than when they do not and about twice as many words when they form a sentence [Erdmann & Dodge (1898)]. A nonsense syllable is psychologically more complex (for apprehension) than a meaningful word since it is less organised than the latter. In short, other conditions being equal the span of apprehension is a function of the coherence (organisation) of the stimulus object e.g. its meaning, grouping, etc.

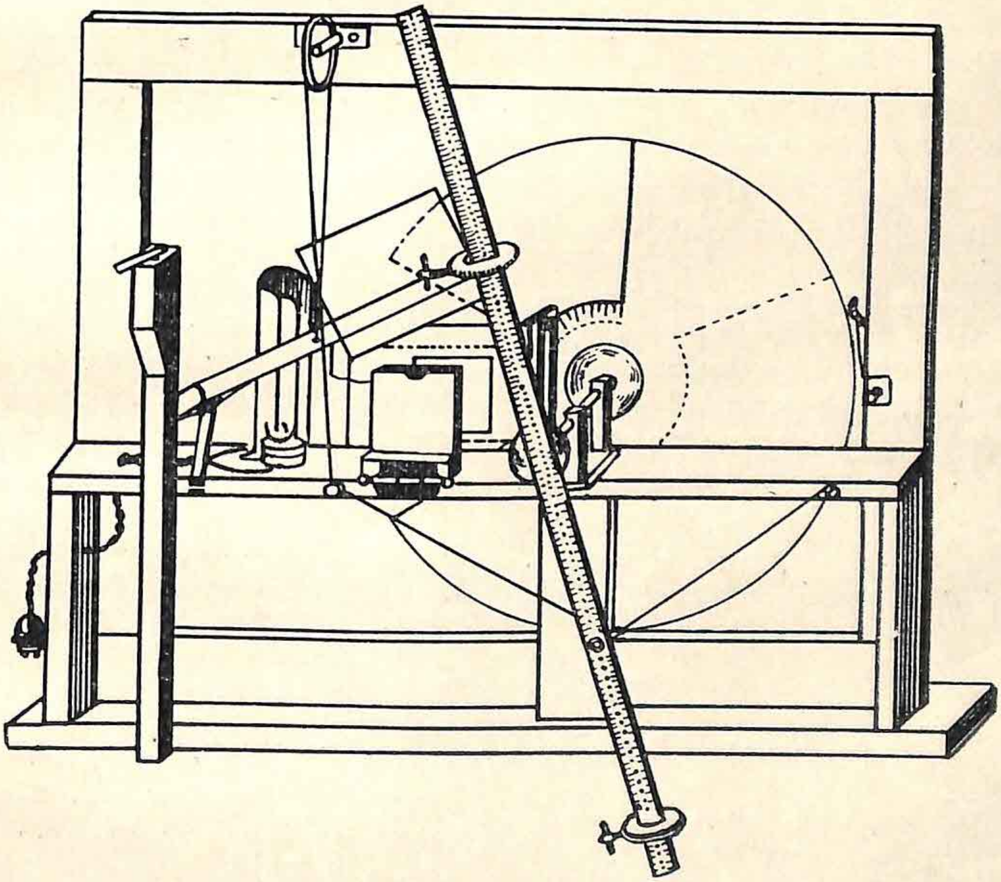

Fig. 13—A Disc Tachistoscope.
(Manufactured by C. H. Stoelting & Co., Chicago)

The present experiment tests the above hypothesis by determining the cognitive limens for disconnected letters, words and sentences by the method of Right & Wrong cases.

MATERIALS & APPARATUS:

1. A Disc Tachistoscope. (Fig. 13)
2. A total of 60 cards, 20 each of letters, words and sentences. The number of letters is varied from card to card in the following way :—

For disconnected letter Cards:—

5 Cards with 4 letters.
5 Cards with 5 letters.
5 Cards with 6 letters.
5 Cards with 7 letters.

For Cards bearing words:—

5 Cards with 6 letters.
5 Cards with 7 letters.
5 Cards with 8 letters.
5 Cards with 9 letters.

For Cards bearing sentences:—

5 Cards each forming a sentence with 7 letters and so on up to and including 10 letters.

The 20 cards bearing disconnected letters should contain each letter with an equal space. Meaningful words are arranged in cards of words, each separated by equal distance, taking care that they do not form a sentence. In a sentence card, different words are combined in a significant manner.

The specimens for 3 types of material, each of 6 letters are shown below in reduced size.

KZDNCV

Disconnected letters.

TOP DIE

Words

I CAN DO

Sentence

In preparing these cards care is taken that no two cards bear the same arrangement of letters and that all the letters appear in the course of the experiment with approximately the same frequency.

EXPERIMENTAL PROCEDURE:

1. The tachistoscope, fitted in a room where the illumination can be controlled, is so adjusted as to give exposure time of 100 milliseconds.

   If a Disc Tachistoscope (Fig. 13) is used then the exposure time of 100 σ is secured by setting the first weight at 5 cms. of the Scale in view (measured at the edge of the weight nearer the release lever when the instrument is ready for exposure) and the second weight at 65 cms. and opening the sector 25 degrees. The overlapping edges of the sector and disc are fastened by pushing a small paper clip over them at the periphery. The entire disc is to be tightened up upon its axis in such a position that it brings the square opening in the disc in alignment with the square opening in the screen.

2. The subject is seated comfortably where he has a clear view of the aperture and the following instructions are given :—

   "After a 'ready' signal, I shall show you for a very brief period of time, cards containing number of letters. The letters may take the form of words, sentence or may be merely disconnected letters. You will be told before each exposure, what kind of material i.e. disconnected letters, words or sentence will be shown. You are to watch closely and immediately after the exposure, reproduce in writing what you have seen. The letters should be written in the same order as that on the card."

3. The 60 Cards are arranged in the following way and the ABC CBA order (Factorial

Design) should be maintained in presenting them to the subject.

10 Cards of Disconnected letters.
10 Cards of Sentence.
20 Cards of Words.
10 Cards of Sentence.
10 Cards of Disconnected letters.

The subject should be told what type of material (letters, words or sentence) is going to be exposed before each series but he is not given to guess the number of letters each card bears. This is done by presenting the cards of each series in a haphazard order.

4. Before each trial, a 'ready' signal is given to the subject and approximately after 5 seconds (the foreperiod) the exposure occurs. The subject is asked to reproduce what he sees by writing on the report-slip given to him. After each trial any one of the cards for the series is inserted in the aperture and the old one taken out which should not be shown any more. The experiment continues till all the 3 series (divided in ABC, CBA order) are finished.
5. Introspective reports for each series are obtained from the subject after the experiment is finished.

RESULTS:

The subject's report is scored right or wrong for each of the cards after examining the subject's reproduction and a table like the following is presented to show the proportions of correct responses for every stimulus-unit and for different types of material.

Stimulus Units	Proportions passing		
	Letters	Words	Sentence
10			
9			
8			
7			
6			
5			
4			

A graph for the above table may be plotted with stimulus-units at the abscissa and the proportions of passing at the ordinate. The 3 kinds of stimulus material may be shown by 3 different inks.

The next task is to calculate the cognitive limen* and S. D.* for 3 types of material by the Summation method where the formulae† given by Woodworth for computing the Cognitive Limen and the S. D. are

Limen = Basal value + i/2 + i Sum p

& S. D. = $i\sqrt{2 \text{ Sum } p' - \text{Sum } p\ (1 + \text{Sum } p)}$

Where Basal value = The stimulus-unit receiving 100% correct reproduction.

Sum p = Sum of the proportions of correct reproduction of Stimulus-units above the Basal value.

Sum p' = Cumulative sum of the proportions of correct reproduction of Stimulus-units above the Basal value.

i = step-interval (Here 1)

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* The Cognitive limen indicates 50% possibility of the stimulus material being correctly reported by 'S' & the S. D. a possibility of 33%.

† Reproduced from R. S. Woodworth's *Experimental Psychology* (1938) p. 403. By permission of Henry Holt & Co., New york, N. Y.

DISCUSSIONS:

1. Is your result in conformity with the hypothesis ? Can you explain why related materials are so readily apprehended ? Does the introspective report throw any light on this ?

(Hints :—The relative difference in the duration of memory images for 3 different types of material can explain the result. We know that the persistence of the memory image is a function of the meaningfulness of the stimulus. Hence the span of apprehension for meaningful materials is relatively larger than meaningless materials, the memory images of which persist shorter than those of the former.)

2. What is the relation between your results and the accuracy and speed with which different types of printed matter can be read ? Is your result related to the proof-reader's illusion ?

(Hints :—Almost every one of us read by the context and not by analysing each letter of the sentence. The more experienced we become as readers, the farther and more 'short circuited' becomes the whole process. For this reason, there are very few good proof-readers. A good author may read a proof sheet half a dozen of times without noticing that a senseless word—not to speak of an error in spelling —is flagrantly evident. The good proof-reader has mastered to a considerable extent the power of suppressing meaning-association. He has counteracted the tendency to read wholes and has substituted more analytic perception for the rapid skimming of the general shapes of word.)

3. The experiment should be called an experiment on the 'Span of Apprehension' and not 'Span of Attention'. Explain why ?

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EXPERIMENT 18

Fluctuation of Attention

INTRODUCTION :

We talk of attending to a task for days and nights, but that the attention is not truly steady is a matter of common experience. Even when we attend to a single proposition for a short time, we cannot say that our attention remains fixed upon it throughout, for now one aspect, and then another has diverted our attention into different channels. The aurist Urbantschitsch, in administering the watch test for hearing, found in 1875 that the watch ticks would some time 'go out' and some time 'come

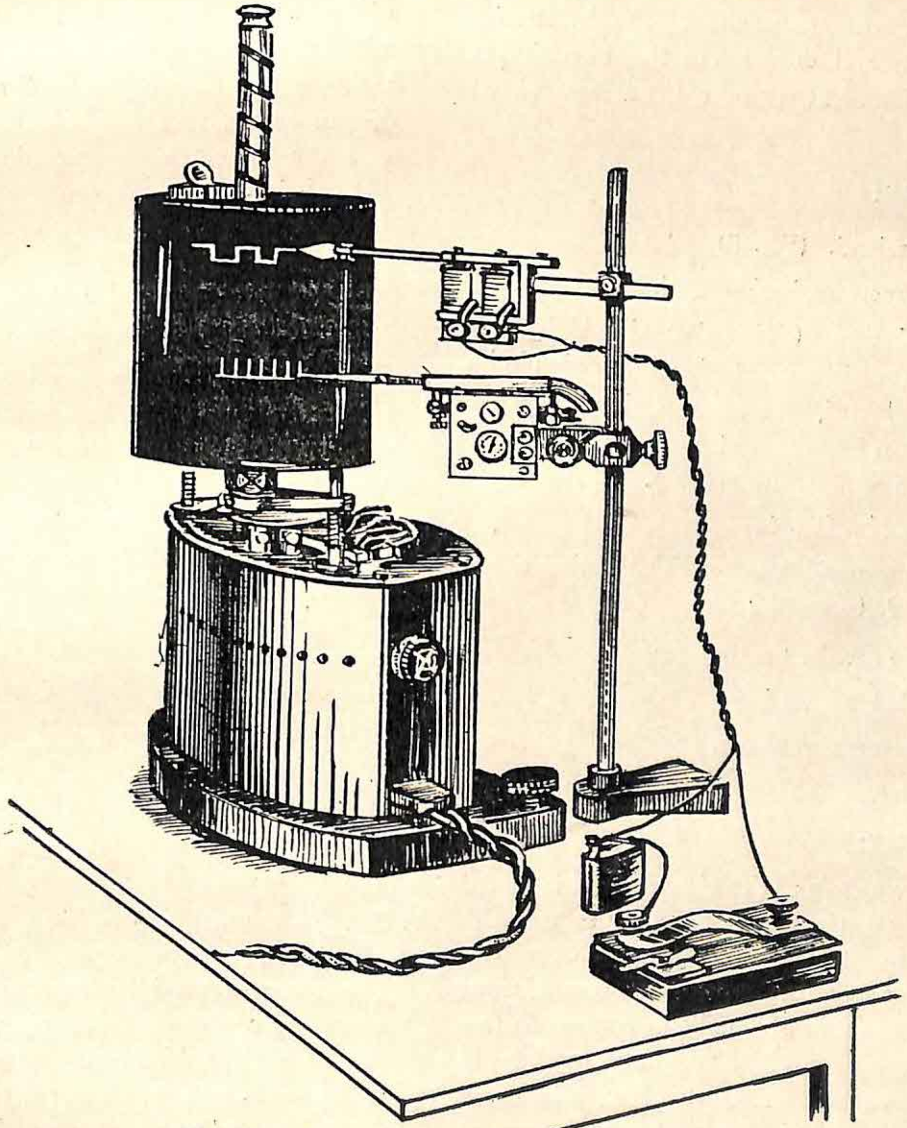

Fig. 14—Accessories for Expt. No. 14 & 18.
(Manufactured by the Technical Corporation, Lucknow)

back'. The alternation of appearance and disappearance occurred at approximately regular intervals. Similar oscillations in attending to faint visual or tactile stimuli were soon observed and the phenomenon received importance in the name of 'fluctuation of attention'. It has been found that the rate of fluctuation differs from individual to individual and in the same individual from time to time. It also varies due to clarity and intensity of the stimulus.

The present experiment simply studies the rapidity and duration of the two phases of fluctuation of attention using a faint visual stimulus.

MATERIALS:

1. Colour wheel. (Fig. 8)
2. Grey screen for background.
3. Masson's disc. (This disc should have a diameter of 20 cms. The black line should be 5 mms. broad, interrupted black pieces 5 mms. in length, and the white space between 5 mms. in length).
4. Kymograph. (Fig. 14)
5. Electromagnetic stylus [Also called time-marker]. (Fig. 11)
6. Battery (2 volts) and wires.
7. A simple reaction key.
8. Smoking arrangements.
9. Chin-rest.

PROCEDURE:

1. The two ends of the glazed paper is pasted tightly on the Kymograph drum and the drum is placed horizontally over the flame of a kerosene lamp and rotated until an even layer of smoke covers its entire surface. Then the Kymograph mechanism is adjusted in such a way that the drum rotates one revolution per 3 minutes (approximately).
2. The connection for the Reaction Key to the Electromagnetic Stylus is made as shown in Fig. 14.
3. The Chronometer and the Electromagnetic Stylus both fixed vertically on a stand are fitted at tangent to the drum pointing towards the direction in which the drum is rotating so that their contacts to the smoked drum give very smooth curves.
4. The subject is seated comfortably in front of the colour rotator and the chin-rest so adjusted that the centre of the knob which tightens the disc comes in line with his line of vision. The Masson's disc is rotated and the subject is instructed to fixate on the third ring of the disc from its periphery. He is then instructed to press the key when he sees the ring and keep on pressing as long as he sees it and to release the key when it disappears and so on.
5. The smoked drum is screened from the sight of the subject and with a 'ready' signal, the actual experiment is started. When a number of readings is taken for 2 mts. the drum is stopped and the subject is given 5 mts. rest pause so as to avoid retinal fatigue. The subject is asked to give his introspection during each rest pause.
6. Now the drum is pushed upwards and another series, recording the two phases for 2 mts. is again taken in the same way. The experimenter can take as many series of trials as possible each for 2 minutes but avoiding the subject's retinal fatigue.
7. Before removing the smoked paper from the drum all necessary information concerning the record should be marked on it e.g. date, speed of the kymograph, unit of time, initial of the subject, etc.
8. After this, the smoked paper is slitted vertically and a clip is attached to each end of it. The record is then put in a thin

solution of clear shellac or lacquer, the smoked side being kept upward and moved gently until it is completely dipped into the solution. The record is then taken out and suspended by a clip till it becomes dry.

RESULTS:

From the record the following measures are calculated:—

1. Number of fluctuations in each 2 mts. rotation and the averages of each series.
2. Total period of positive and negative phases in each rotation and their averages.
3. Ratio of duration of positive phase and negative phase calculated by the following quotient:—

$$\frac{\text{Average Duration of Positive Phase}}{\text{Average Duration of Negative Phase}}$$

DISCUSSION:

The following questions should be answered:—

(1) Which of the phases was dominant with regard to duration and number of occurrences?

(2) Do you think that the duration and number of occurrences of these two phases solely depend on the stimulus factor? Has 'mental set' (instructional set) any influence on the results obtained ?

(3) What are the main theories postulated to explain the phenomenon of fluctuation of attention ? What explanations have you been able to discover during your readings? Does the introspective report of your subject throw any light on this matter ?

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EXPERIMENT 19

The Effect of Noise upon the Performance of Different Tasks.

INTRODUCTION:

Noise according to commonsense is always harmful as it impairs the output of the person working under a noisy condition. A problem of great practical importance concerns the influence of noise upon 'mental work' since noises seem to be great disturbing elements according to common notion. As Morgan states, "We know that in the readings of a particularly interesting book we can become entirely oblivious to everything about us, even severe noises. But none of us will seek a particularly noisy place to take over reading, no matter how interesting it may be. If we have some hard mental task, noise becomes really distasteful to us. It is then an important problem to determine just what the effect of a situation replete with irrelevant noise is upon our performance"*.

The problem has been variously touched by several experimenters but different results have made the problem more complex. In fact Morgan, the pioneer in this field, after an extensive research had to conclude "Our work thus far has simply served to show that noises have some effect upon work and that the effect is a complex one". Yet one thing that has become clear is that the effect of noise on the performance of different tasks is not the same. Before Morgan, many attempts were made to determine experimentally the effect of noise upon the performance of various tasks, such as reaction-time, visual discrimination, speed of tapping, arithmetical operations etc. From these studies it can be said in general that tasks which become automatic by practice are relatively uninfluenced by noise.

The present study makes a comparative study of two different tasks as influenced by noise.

MATERIALS:

1. Auditory distractor such as the beat of hammer on a drum,
2. Stop watch.
3. 40 strips of paper in which single digit numbers and letters are mixed in random order forming a row from left to right as in the following specimen adapted from Ford. †

Gd7FC8fɪaw9M6CO

PROCEDURE:

The experiment is divided into two parts. The first part deals with the influence of noise on a simple task like writing *ababab* etc. 20 times in each trial as rapidly as possible. In Part 2, we have to study the effect of noise on a task that calls for adding all single digit numbers from the row of mixed letters and numerals and writing their sum at the end.

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* Reproduced from Morgan, J.J.B.–"The overcoming of distraction & other resistances' *Archives of Psychology*, 1916, No. 35. P, 2.

† Ford. A.–"Attention–automatization—an investigation of the transitional nature of mind". *American Journal of Psychology*, 1929, 41, Pp. 1–32.

Part 1.

1. The subject is seated comfortably and a bound composition book is provided to him. He is instructed to write *ababab* etc. twenty times in each trial as rapidly as possible. The writing is done on the composition book. The page is turned at the end of each trial as soon as 20 *ababab* etc. are written.
2. The subject is required to do the task under the following two conditions. (a) In which no distraction is introduced and (b) in which distraction is introduced continuously.
3. In all, 40 trials are given to the subject. The order of the conditions is planned according to the following design (counterbalanced order):—
   First 10 trials for condition 1 (Quiet).
   2nd 10 trials for condition 2 (Noise).
   3rd 10 trials for condition 2 (Noise).
   Final 10 trials for condition 1 (Quiet).
4. All these four series are followed successively with no gap in between them so as to counterbalance the effect of practice and fatigue. After each trial, the experimenter records the time taken in writing *ababab* etc. 20 times.
5. The subject is requested to note his mental state during each of the four series which he is to write down at the end of the experiment.
6. The task is started with the 'ready' signal and immediately after the first series of the quiet condition, the subject is warned of the distraction and the drum is struck with the hammer continuously till the two series of the noise condition are over. Then the subject again works in quiet condition for 10 trials.

Part 2. (Noise influencing a complex mental task)

1. The procedure here is exactly the same as in Part 1. Before the experiment proper starts, the subject is made familiar with the task by solving one sample problem.
2. He is asked to write down at the end of the slip the sum of the single numerals scattered throughout the series of alphabets in no predictable order, either as to spacing or to kind.
3. Output in this part of the experiment also is measured in terms of speed (time) with which the subject finishes each strip. 40 trials are given here, each trial consists of summing up the numerals of one individual strip. The time is recorded after the addition is made and this is done for all the 40 trials.
4. Here the 40 trials are also divided in 4 series as in the previous part.
   10 trials in Quiet Condition—1a Series
   10 trials in Noise ,, —2a ,,
   10 trials in Noise ,, —2b ,,
   10 trials in Quiet ,, —1b ,,
5. Here also the introspection is taken after all the 4 Series are finished.

RESULTS:

The time required in writing 20 *ababab* etc. in each trial of the first part of the experiment and the time taken in summing up each strip in each trial of the second part of the experiment are presented in a table like the following :—

Series	Conditions	Time in Seconds taken in each trial											
		1	2	3	4	5	6	7	8	9	10	Mean	S. D.
1 a	First Quiet												
2 a	First Noise												
2 b	Second Noise												
1 b	Final Quiet												

The tabulated data are also graphically presented showing time at the ordinate and successive trials at the abscissa.

The necessary statistics (S. D. and '*t*' ratio) are then computed and they are presented in a table like the following:—

Nature of Task	Quiet Cond. (1a+1b)	Noise Cond. (2a+2b)	S. D.		σM		σD	't' ratio	Significance level
	Mean time	Mean time	Part 1	Part 2	Part 1	Part 2			
Simple (Part 1)									
Complex (Part2)									

DISCUSSIONS :

The following questions should be answered with reference to the results obtained:—

1. Which of the tasks was (a) more and which (b) less affected in speed by noise ?
2. Which task showed more adjustment with the introduction of noise ? For which task noise became more distractive ? Did introspective report support the quantitative data ?
3. Which task is more impaired in speed with the onset and cessation of the noise ?
4. If distraction is thought as a form of attention, what light do your results throw on the so called phenomenon of 'division of attention'? (Hints:—If the writing of *ababab* etc. is not influenced by noise, then it supports the view that division of attention (shift) is possible when one of the two discrete acts becomes automatic).

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EXPERIMENT 20

Study of Habit Interference (Card-Sorting)

INTRODUCTION :

The faculty psychology declared that learning of any kind would make learning of another kind quite easy. Practice in one performance according to this notion has a facilitating effect on all lateral learnings, even in other performances. This statement is now famous in the name of Doctrine of Formal Discipline. For a long time a belief in the truth of this principle remained the basis of most educational policies till experimentations in the field of learning demonstrated that the effect of learning in one performance on learning another performance is not always facilitating. The data from these experiments indicate that we can expect three possible effects. A habit, once acquired, may facilitate the learning of another skill. This is known as 'positive transfer' of training. In another situation, the acquired skill or established habit may affect nothing at all upon the process of developing a new one. In a third type of situation, the already established habit interferes with and slows the process of learning another habit. This is known as 'negative transfer' of training or 'habit interference'. There are many everyday examples of habit interference. A person accustomed to carrying the pocket-watch in his shirt, when starts keeping the watch in the trouser, he makes a number of false moves in bringing the watch into position to find out what time it is, until the new ways required become thoroughly habituated.

Negative transfer is usually studied in the psychological laboratory either by learning a new maze after having mastered an old one or by practising type-writing on a different keyboard from that originally used or sorting cards into two differently arranged series of compartments. From these experiments, we find that for efficient learning, two mutually interfering habits should not be practised simultaneously. It is better to acquire one habit before starting with the other. This is because interference occurs markedly during the beginning of habit formation. The interference becomes less and tends to disappear more rapidly as learning progresses.

The purpose of the present experiment is to study the progress of learning in card-sorting and to measure the amount of interference and the recovery from it, due to changes in location of the sorting compartments.

MATERIALS :

1. Sorting placard 22 × 22 inches, divided into four equal squares by heavy black lines, each section labeled with the symbol of one playing card suit.
2. A pack of 60 playing cards, made up of 15 cards in each suit (Jacks, Queens, Kings, Aces, and Jokers removed).
3. A Stop watch.

PROCEDURE :

1. The sorting cardboard is placed with one side even with the edge of the table and the 'heart' compartment in the far (from 'S') left section.
2. The subject stands directly in front of the placard during the sorting and he is asked not to change his position throughout the experiment.

3. The pack of cards is shuffled well and held face down and given to the subject.
4. The subject is instructed as follows :—

   "At the signal 'go', you are to turn over the top card and sort it in the 'Club section' if it is a Club, in the 'Heart section', if it is a Heart and so on.

   Ascertain the suit of the card; locate the corresponding compartment and then throw the card face up into it. In this way, sort the cards by suit as rapidly as you can. Disregard the numbers on the cards. Pay attention only to the suit. Work as rapidly as you can and correct your errors as you go along. Your time record will be penalized for failure to correct an error."
5. After ascertaining that the subject understands the direction, the 'Ready' signal is given and the stop watch started until all the cards are sorted. The time taken and the errors made in the trial are noted. 20 such trials are taken with a rest pause of one and a half minutes (approx.) between each trial during which the experimenter reshuffles the cards and enters the data in the outline form (Table followed) without the knowledge of the subject.
6. In the 'Hesitancy' column, the number of times the subject showed hesitancy in sorting is noted. In the 'Partial Correction' column, the experimenter notes the number of times a correction was made in the half way before a card was sorted in a wrong compartment. In the 'Correction' column, the number of errors corrected after sorting is noted. The 'Error' column, is entered after the trial when any wrong sorting is found. In the 'Comment' column, any behaviour or comment from the subject that may help to explain variation in his behaviour is noted.
7. The sorting placard is now rotated 90° to the right bringing the 'Heart Section' to the upper right hand corner. The subject is given 5 trials with this position. The time taken and other behaviours are noted in the way already stated.
8. The subject is asked for a verbal report concerning his mental state during the experiment. He is also asked to report specifically any interference felt by him at the final 5 trials.

RESULTS

The raw score is tabulated in a table like the following :—

Trial	Time in Seconds.	Error (if any)	Hesitancy.	Partial Correction.	Correction.	Comments (if any)
1						
2						
3						
...						
...						
18						
19						
20						
Average						
1						
2						
3						
4						
5						
Average						

The averages for the 20 trials and the last 5 trials are computed and compared. If the average time taken in the last 5 trials is significantly greater than the average of the first 20 trials, the phenomenon of negative transfer is said to be demonstrated.

Learning curve for the whole 25 trials is drawn on the same line in terms of time taken and a break in the curve between the 20th. and 21st. trials is left to indicate the changed condition. Learning curves for Hesitancy, Partial correction and Correction (if any) are also drawn and a comparison between the two conditions is made with the help of these learning curves.

DISCUSSIONS :

Questions to be answered here are the following :—

1. What evidence do you have in this experiment that habit interference has been demonstrated ? Indicate which comparison (1st. & 20th. trial or 20th. and 21st. trials) gives the most unequivocal evidence of negative transfer.
2. What additional evidences do you have from the subject's behaviour and remarks that there was interference under the changed condition of the experiment ? How much recovery from interference was there by the 25th. trial ?
3. Can you suggest other methods of studying habit interference other than that used above ? Does the method have any advantage not possessed by those that you suggest ?
4. What can you conclude concerning
    (a) the trend of learning in card-sorting
    (b) habit interference ?
5. Which of the theories favours to explain the habit interference taking place in the above experiment ?

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EXPERIMENT 21

Study of Bilateral Transfer

INTRODUCTION :—

It is worthnoting that the scientific study of transfer of learning or training began with the question of Bilateral transfer. Weber, the father of Psychophysics, noted that some children trained to write with the right hand were able without further training to produce very good mirror-writing with the left hand. This carrying over of an act learned by one hand to the performance done by other hand is called 'Bilateral transfer'. Thus 'Bilateral transfer' is the transfer of skill from one bodily member to another. From many experiments, it appears that skill acquired with one hand can often be carried over to the other hand or even to the foot —though often but not in every case. Ball tossing showed transfer from the right hand to the left in five of Swift's 6 subjects. In terms of saving, the transfer effect was large, amounting to about two-thirds of the work which would otherwise have been required from the left hand.

Both negative and positive transfer are illustrated in mirror-drawing. The marked habit interference present during the early trials affords an opportunity to observe negative transfer. In the mirror-drawing experiment in which the subject learns to trace a pattern while viewing its reversed image in a mirror, the familiar situation is altered. The eye-hand-co-ordinated behaviour built up in the past, while reacting to visual and kinesthetic stimuli, gets disturbed in mirror-drawing. A new eye-hand co-ordination, which runs counter to previous smoothly working ones, must be formed now. But in the process of its formation, particularly during the early trials of mirror-tracing, some kind of trial and error behaviour usually results even if the subject thinks ahead and engages himself in rational planning.

The purpose of the present experiment is (1) to observe a typical example of trial and error learning in mirror-drawing (2) to observe interference or negative transfer from the habit of long standing to mirror-drawing, and (3) to study specifically transfer of skill from one musculature to another.

MATERIALS :

(1) Mirror-drawing set-up (Fig. 15) consisting of holder for star outlines, (2) Screen, (3) 32 star outlines, (4) A pencil, (5) A stop watch, (6) Paper clips.

PROCEDURE :—

1. All the star outlines are numbered and placed serially.
2. On the board of the mirror, a copy (No. 1) of the star pattern is placed in such a position that it can be seen completely in the mirror. Clips are used to fasten the star outline with the cardboard tacked on the mirror-board.
3. The screen is placed in such a way that the subject cannot see the star except in the mirror.
4. The subject is seated comfortably before the mirror and the following instruction is given :—

"The point of your pencil will be placed at the uppermost point of the star as seen in the mirror. When I say 'go', you are to trace between the lines, moving in the direction indicated by the arrow as seen in the mirror. Your pencil line must pass through the two lines. If it crosses any of the lines, it will be

counted as an error. If you move from the centre of the path, return to it as quickly as you can. The object is to go as rapidly as possible without crossing the lines. You will be credited in terms of your quickness to traverse the star and also in terms of your accuracy to keep the pencil within the lines".

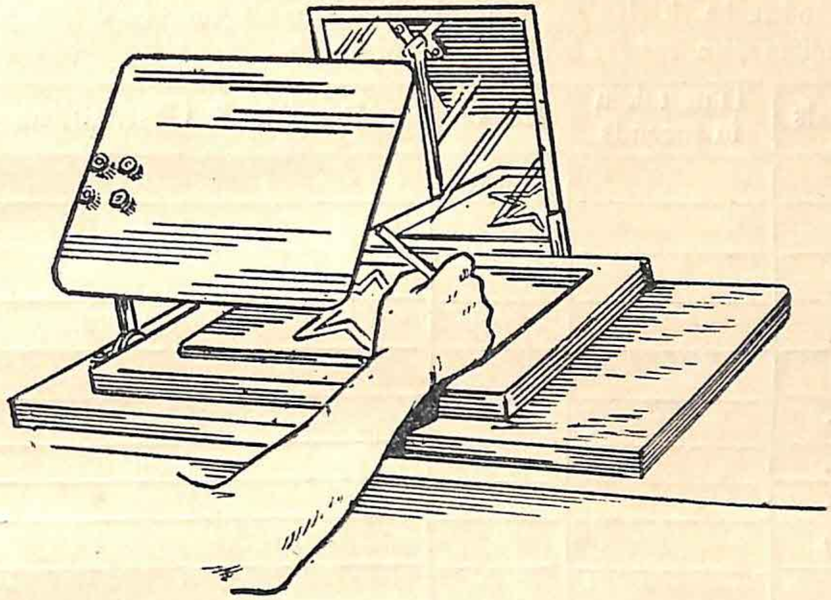

Fig. 15. A Mirror Drawing Apparatus.
(Manufactured by The Technical Corporation, Lucknow)

5. 25 trials are taken successively with the following design :—

   1-2 (inclusive) with Left (unskilled) hand.
   3-22 (inclusive) with Right (skilled) hand.
   23-25 (inclusive) with Left (unskilled) hand.

   The tracing is done in a counter clockwise direction with the right hand and clockwise with the left hand. The starting points are marked according to the hand to be used on each star pattern before the experiment starts.

6. The time taken in each trial is recorded and under 'Remarks and Observations' column of a table like the following, record of any comment from 'S' or any observed behaviour which may indicate or explain his attitude is noted.

7. The tracing done by the subject is kept concealed underneath the screen at the end of each trial. The star patterns are changed by the experimenter himself. It is important for the subject to do only star tracing with his hand throughout the experiment and not to see his hands except in the mirror. This is maintained as a constant set for all the 25 trials.

8. After the whole experiment, the subject is asked to indicate what he believes to be the basis of his improvement in eye-hand-co-ordination. By questioning the subject, an attempt is made to determine how much definite planning aided his progress in early trials and in later trials. He is also asked how he oriented his movements and whether he could note the disappearance of the visual distortion as his learning progressed which enabled him to see the star in the mirror in its correct right-left position.

RESULTS :

The learning curves based on the time taken* and errors made in each of the 25 trials are plotted in a graph. The changed conditions at the 3rd and 21st trial are indicated by a break in the curve. From the curve, it would be apparent whether negative or positive transfer occurred for the left hand. If there is a fall in the average time score for the left hand in the last 3 trials (trials 23-25) as compared to the average of initial 2 trials, the positive effect is demonstrated and the difference between the average of initial 2 trials and the final 3 trials roughly determines the amount of transfer.

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* The distance travelled in each trial may also be used.

Trials	Time taken in seconds	Errors	Remarks & Observations
1			
2			
3			
4			
5			
...			
...			
...			
20			
21			
22			
23			
24			
25			

The development of eye-hand-co-ordination is studied by calculating the amount of fall in average time and errors in the last 5 trials of right hand (Trial Nos. 18-22) as compared to the average time and error shown for Trial Nos. 3-7 (both inclusive).

The nature of negative transfer during the early trials is also found by the amount of errors and time taken.

DISCUSSIONS :

Questions to be discussed here are :—

1. From an analysis of the subject's comments and your notes on his behaviour, describe the nature of trial and error behaviour in mirror drawing. By what means did the subject direct his movement in the proper way ?. To what extent did planning help in early trials and in later trials ?
2. What was the nature of the negative transfer during the early trials ? What type of distortion was produced by the mirror ?
3. Did the visual distortion disappear as the learning of mirror tracing progressed ? How correctly it enabled the subject to see the star in its right-left positions ?
4. What kind of transfer occurred from right to left hand ? How do your experimental results compare with those of Ewert who demonstrated disruption of former habits (spatially co-ordinated behaviour) as produced by inversion of the retinal image ?
5. Indicate the general conditions which determine whether transfer effects will be

positive or negative. What factor favouring transfer is most potent in your experiment?

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EXPERIMENT 22

Transfer of Principle

INTRODUCTION :

Transfer of training has been studied mainly in relation to sensory discrimination, motor skill and formal training in the school subjects. But it has particular importance in relation to problem solving. Gestalt psychologists argue that positive transfer in solving problem is found only when the problem is solved in terms of a general principle. Empirical and 'rule-of-thumb' methods of solving a problem do not lead to transfer of related problems.

Numerous experiments are there (that of Judd, Hendrickson and Schroader and many others) to support the findings of Woodrow that transfer is facilitated when the initial learning can be formulated in terms of general principles applicable to new learning.

Further evidence relating to this problem is furnished by the ingenious experiments of Katona where geometric puzzles, cards and match-sticks were used as learning materials and transfer tested with puzzles embodying the same general principles. One group was instructed to memorize the initial solution and was given practice through repetition. The second group was taught the principle involved. A control group received neither practice nor the principle was told. The percentage of correct solution to new puzzles was greatest for the group knowing the principle (Principle group) and the least for the Control group. The difference between the Principle group and the Memorizing group was also statistically significant.

Katona attributed the difference in the amount of transfer to the superiority of meaningful over 'senseless' learning. By senseless method of learning, he meant simple conditioning etc. and by meaningful, he meant 'apprehension of relations' and 'insight into situation'. He concluded that although meaningful learning might be transferred to new situations, senseless method would not. Katona observed that by 'rule-of-thumb' method, we can learn the 'how' of the problem but not the 'why' of its solution.

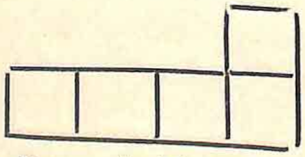
The present experiment is a replication of Katona's experiment with a view to demonstrating the phenomenon of transfer of principle.

MATERIALS :

1. 16 match sticks.
2. One stop watch.

PROCEDURE :

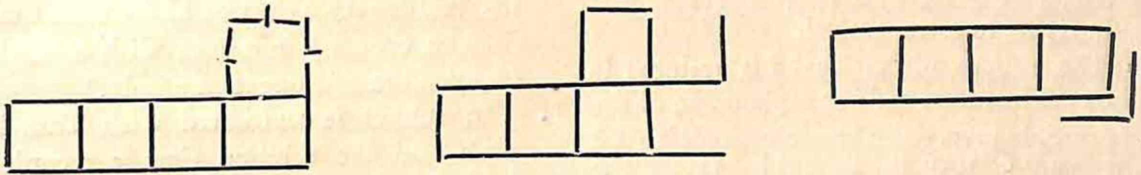
1. 16 match sticks are arranged in such a way as to form the pattern shown in the following figure :—



Pattern for Task No. 1

The subject is instructed to make 4 squares out of the 5 squares given in the above pattern by changing the position of 3 match sticks only. He is further explained

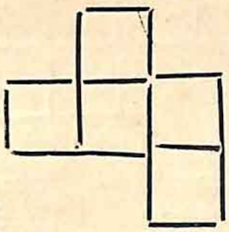
(a) not to take match sticks away—that is, all match sticks must be used in new patterns, (b) not to include in the pattern matches which do not form side of a square, and lastly (c) not to duplicate matches in making side of a square. Thus, the arrangement shown in the following figures are not permitted as solutions.



Non-permitted patterns.

2. The subject is allowed 3 minutes only in which to reach the solution as patterned below. He will probably fail. This is all for Task I.

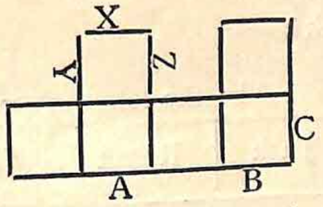
3. The experiment now proceeds with Task No. 2. In preparing Task II, 16 match sticks are arranged to form pattern as shown below.



Pattern for Task No. 2

The subject is instructed again to make 4 squares out of the given pattern of 16 match sticks by altering the positions of 3 match sticks only and with the same provisions as Task I. Three minutes are allowed for the solution. It is very likely that he will fail to solve this problem too.

4. The next step is to demonstrate the subject the solution of Task I in the following way. The match sticks marked A, B, & C are removed and then replaced in the position marked X, Y & Z respectively in the following figure :—



Solution of Task No. 1.

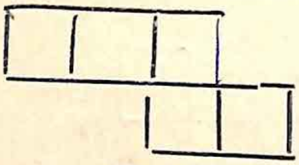
The subject is allowed to repeat the solution to make it sure that he can formulate and demonstrate it unhesitatingly. The number of trials taken to do so and the time for each trial is recorded.

5. After the subject has learnt the solution of Task I, he is confronted with Task II to see whether or not any transfer occurs. The time allowed for the solution is 5 minutes this time. It is unlikely that the subject will manage to solve it despite his knowledge of how to solve Task II. If he solves at all, he is to explain the method adopted in the solution. If he can say the principle involved in the solution, he should be continued with Step No. 9 of the procedure.

6. In the event of his failure to solve Task II, 'S' is again given to do Task I. His solution time is recorded. If he solves the task promptly and accurately, we can be sure that this knowledge does not help him in trying to solve Task II.
7. The pattern of the Task I is restored in its original form and the explanation of the principle involved in the solution of Task I is made clear to the subject by saying the following :—

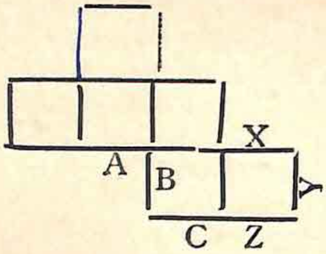
"Here are 5 squares of 16 match sticks. We want to change these 5 squares into 4 squares. Since we have 16 lines and want 4 squares, each square must have its 4 independent lines which should not be side lines of any other square at the same time. Therefore, all lines with a double-function i.e. limiting two squares at the same time must be changed into lines with a single function limiting one square only."

8. The subject is confronted with Task II again and the solution time is recorded (solution given in the figure below).
9. After he succeeds to solve Task II, he is given Task III, the pattern of which is shown as follows :—

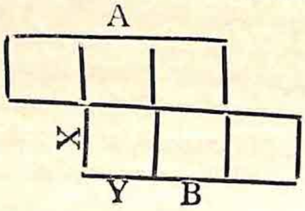


Task III

The instruction already given is repeated with the exception that only 2 matches are allowed to be removed in this task. Time to solve the task is again recorded. Introspection is requested from the subject. The data are treated to assess the influence of (a) the rules-of-thumb solving (b) solution in terms of a general principle.



Solution of Task 2



Solution of Task 3

RESULTS:

The data are presented in a table like the following :—

Successive conditions	Task	Result	Time Limit	Time taken by 'S'
Neither the solution demonstrated nor the explanation of the solution offered.	I		3 mts.	
	II		3 ,,	
Only the solution of the Task I demonstrated.	I		3 ,,	
	II		5 ,,	
	I		3 ,,	
Explanation of the solution added.	I		3 ,,	
	II		5 ,,	
	III		5 ,,	

DISCUSSIONS :

1. From the results obtained, show how 'rule-of-thumb, does not help in understanding or solving problems of the same type.
2. Was there any transfer when the explanation of the general principle required for the solution was given ? How are you going to demonstrate it ?
3. Can you explain why the acquisition of general principles usually produces more transfer than is yielded by the memorising of specific facts ?

   How does the identical element theory of Thorndike explain it ? In what ways the identical element theory falls short of explaining transfer of principle ? What is the interpretation given by Katona himself of his results ?

   (See especially in this connection the chapter written by Hovland in Steven's (Editor) *Handbook of Experimental Psychology.*

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EXPERIMENT 23

Learning & Retention of Related & Unrelated Word-pairs

INTRODUCTION :

From our everyday experience, we know that when one item of a pair of associated words is uttered, the other item easily comes up in the mind. This is the factual meaning of the much used term 'association'. If for example, we find that the word 'Class' evokes the response 'Teacher', then the two words are said to be associated. Thus, when any meaningful relationship exists between two items, they are said to be associated. Since the days of Ebbinghaus, several experiments (by Calkins, Jost, Muller & Pilzeker and Thorndike) have been done which verified the fact that such associated or related words are more easily learnt than words having no relationship between each other.

The purpose of the present experiment is to demonstrate the fact that related word-pairs are more easily connected and better retained than unrelated word-pairs.

METHOD :

The paired-associate method combined with prompting method is to be employed here. After one presentation of the list in pairs, the stimulus word of each pair is presented and the subject is allowed a certain time-limit.(2-3 secds.) for giving the response. He is prompted whenever he fails. The trial is continued till the whole list is learnt.

MATERIALS :

1. A list of 10 related word-pairs.
2. A list of 10 unrelated word-pairs (See, Woodworth's *Experimental Psychology*, page 10 of 1938 edn.)
3. An exposure sheet on which two slits are cut out with some distance apart through which the word-pair can simultaneously be exposed.
4. A Metronome to control exposure time.

PROCEDURE :

The experiment is divided into two parts. Part one deals with the learning and retention of unassociated pair of words. In the second part which follows 10 mts. after the first, a study is made of the learning and retention of associated word-pairs. The procedure for both parts of the experiment is the same.

Part 1.

1. Before the experiment starts, the subject is given the following instruction :—
   "I will show you for a brief period of time two words at each exposure. Your task is to remember the second word of each pair so that in the second trial when the first member of a pair is shown, you can anticipate its correct pair. The material will be presented in a rearranged order and hence it will not do if you memorize in the order in which they appear. Your task is simply to learn the correct associate of the first item of each pair. If you fail to anticipate it when asked, you will be prompted. The trials will be continued till you can anticipate the correct associate of all the first items of the word-pairs".
2. The list of unassociated word-pairs is tacked by 2 drawing pins on the table and the exposure sheet with double slits cut on it, is moved at a uniform speed exposing each word-pair for 3 seconds.

3. After all the 10 word-pairs have been exposed one by one, one of the slits of the exposure sheet is closed and the first members of the pairs are presented randomly and the subject is asked to give the correct associate.
4. The subject is prompted whenever he fails to anticipate within 3 seconds.
5. The trials are continued till a perfect score is attained by the subject and his progress is traced trial by trial for each item and for the whole list.
6. After the whole list is completely learnt (1 errorless anticipation of the whole list), a rest pause of 10 mts. is given during which the subject is first asked to give introspection and then he is amused with light humours which might check the subject's tendency to rehearse the list learnt.
7. Immediately after this rest pause, the first members of the learnt list are shown one by one in a random order and the subject is asked to anticipate their respective associate each within 3 seconds. The percent he correctly anticipates constitutes his retention.

Part 2.

In the same way, the associated word-pairs are learnt by 'S'. The number of trials taken to associate correctly each of the first items with the other member is recorded till all the items are learnt. After a rest pause of 10 mts. during which the subject is engaged in writing his introspection and then amused with light humours, the retention is measured in the way already stated.

RESULTS :

The data showing the subject's progress from trial to trial for the two lists and for each item are tabulated in a table like the following :—

Trials	Percentage of success		Items*	Trials taken to learn	
	Associated	Unassociated		Associated	Unassociated
1			1		
2			2		
3			3		
4			4		
5			5		
6			6		
7			7		
8			8		
9			9		
10			10		

* Items serially written on the list and not in the order exposed which should be haphazard.

The percentage of success from trial to trial for the two lists should be plotted with percentage at the ordinate and successive trials at the abscissa.

The principal result is then tabulated in a table like the following :—

Material	Number of trials to learn the whole list.	Percentage retained after 10 mts.
1. Unassociated.		
2. Associated.		
Difference between 1 and 2		

DISCUSSIONS :

Questions to be discussed here are :—

1. What is the relative difficulty of learning associated and unassociated pair of words? Is the retention for both types of material proportional to the respective learning difficulty? Quote the relevant figures.

2. What is the usual explanation offered for the fact that associated (meaningful) materials are both more easily learnt and better retained than unassociated materials? What have you to say about the adequacy of the usual explanation in terms of the difference in initial habit strength of component associations.

[*Hints* :—Sheffield (1946) has questioned the usual explanation and has offered a substitute which is as follows :—

"Meaningful materials are more easily learned because, as stimuli, they are already discriminated from each other by virtue of being associated with distinctive implicit reactions"]

3. Do you think that we learn by 'association' only? What role of motivation do you find from your subject's introspection while he learnt the unassociated word-pairs?

[*Hints* :—Mention the 'suggested meanings' which the subject employed to learn the unassociated word-pairs (See Woodworth's *Experimenta Psychology*, 1938, p. 34). This linking of two unrelated pairs by suggested meanings, and extra ideas makes it possible to learn unassociated pairs and greater motivation is, therefore, needed here than learning of associated pairs. The subject has to spend extra energy for it. So the attitude of the subject becomes another important factor of learning (Quote Lewin's work)].

4. Do your results support in any way the following law of Jost. "If two associations are now of equal strength but of different ages, the older one will lose strength more slowly with the further passage of time".

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EXPERIMENT 24

The Context factor in Recognition

INTRODUCTION :

That recognition is easier than recall is a commonly known fact and has received much experimental support. We know that a face is promptly recognised even when the identity is not recalled. But recognition should not be thought as too easier. The ease or difficulty of recognition depends upon the context in which the recognition is tested. If for example, 'S' learns a list of adjectives and then he is placed to recognise them among a group of nonsense syllables, his recognition score would be greater than if he is to recognise the learnt adjectives among a group of another adjectives.

Lehmann (1888) found in a recognition test of gray colours that as the differences between new items (grays of different intensity) and the recognition object (neutral gray) tend towards zero, the percentage of recognition diminished. As the old and new items became very much alike, recognition failed.

Further light on this matter was ingeniously thrown by Seward (1928). In Seward's experiment, 30 fancy papers of varied designs were presented to the subject each for 2 seconds when all the materials had been shown, a Test list was made which contained items that were identical, similar, slightly similar and dissimilar to the original 30 papers. After 10 mts., the Test list containing 30 old items and 90 new items was presented to be discriminated from the original. It was found that false recognition increased as the Test list became very much alike the original up to the point of being nearly identical.

Seward's results supported the findings of Lund (1926). In Lund's experiment nonsense words of 5 letters were made similar, slightly similar and dissimilar to the original nonsense words of 5 letters. Lund found that when these similar objects were randomly mixed with the original items in the Test list and shown to the subjects, recognition score tended towards zero as similarity between the original and new items increased to near identity. False recognition was greater for items that were similar to the original, than for items identical, slightly similar and dissimilar. It was minimum for items quite dissimilar to the original. Thus, it was demonstrated that the accuracy of recognition depends heavily upon the homogeneity of the sample in the recognition test.

From this, we can formulate the hypothesis that starting with near identity, increasing degrees of dissimilarity of the new items to the original items included in the Test list, will make the recognition easier.

The present experiment is designed to test the above hypothesis.

MATERIALS:

(1) 4 lists each of 10 nonsense words like the following:—

List 1	List 2	List 3	List 4
(Original)	*(Similar)*	*(Slightly Similar)*	*(Dissimilar)*
MOLEC	MOLEQ	NOLEQ	VULEQ
RENUB	RANUB	RANUG	RANOY
KIDUV	KIDOV	LIDOV	FUDOV
FELAG	FELAQ	FELOB	FULOB
HIZUS	HIJUS	HEJUS	TOZUS
LIXAB	LIXAV	LEXAV	LEXOV
YOTEM	YOTAM	YOTAN	YUTAW
POFEZ	POFEJ	POFAJ	POFUG
BANUP	BENUP	BENOP	BEMOP
VIQUR	VIKUR	VIKUS	VIKAN

The Test list is prepared by mixing the 4 lists haphazardly.

2. A paper screen or exposure sheet (like that described already) with a narrow horizontal slit through which, one nonsense word at a time will appear as it is slided over the list.

3. A metronome adjusted to beat once every 2 secds.

PROCEDURE:

1. The subject is seated comfortably. List 1 (original) covered with a blank sheet on it, is then placed before 'S' for partial learning.
2. He is then instructed as follows :—
   "At a 'ready' signal, you please slide down the paper screen and expose through its horizontal slit one word at each beat of the metronome. You please see attentively to each of the nonsense words which will be presented for recognition after some time. When you have reached the end of the list, you please slide over the paper screen and start from the top for a second time in the same way. Five such successive exposures of the whole list will be made".
3. As soon as the 5 exposures are finished the subject is engaged in light conversation for 2 mts. which is expected to check him rehearsing the materials of List 1.
4. Immediately after this, the Test list, in which List 1 (identical to the original) List 2, (similar), List 3 (slightly similar) and List 4 have been mixed haphazardly, is presented before the subject. 'S' is then asked to recognise the words of List 1 responding to each of the items of Test list by saying 'yes' or 'no'. He is to say 'yes' to those items which he believes, were exposed to him during the learning session.

RESULTS :

The raw data may be tabulated in the way shown by Seward (Woodworth's *Experimental Psychology*, 1938 edn., page 18).

	Success	Failure		
	Identical	Similar	Slightly Similar	Dissimilar
Positive Response of 'S'.				
	Failure	Success		
	Identical	Similar	Slightly Similar	Dissimilar
Negative Response				
Total No of Responses	10	10	10	10

[According to the hypothesis, the number of positive responses for materials other than identical to the original will go on decreasing as dissimilarity increases and for negative response it would be just the reverse]

The next task is to calculate the Recognition Scores for each of the conditions where context factor has been varied. In doing so, we will have to assume that the 3 Test lists, one by mixing List 1 and List 2, another by mixing List 1 and List 3 and the last one by mixing List 1 and List 4 were used successively. The formula applied in each case for deriving the Recognition Score in terms of percentage would be:—

$$\text{Recognition Score} = 100\left(\frac{\text{Right} - \text{Wrong}}{\text{N}}\right)$$

where Right = the number of correct responses to all stimuli, Wrong = number of items incorrectly sorted & N=total number of items including the doubtful ones in the Test list (here 20)

The recognition scores thus calculated are presented in a table like the following :—

	Recognition Score when the context varied in the following way.		
	Similar	Slightly Similar	Dissimilar
Recognition Score			

This table is graphically presented by plotting the Recognition Scores at the ordinate and the different degrees of similarity at the abscissa.

DISCUSSIONS :

The following questions should be answered :—

1. How are the results congruent with your hypothesis ?
2. Can the results in any way be explained in terms of the transference theory of Retroaction ? How does the factor of 'set' (situational) influence the recognition ?

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EXPERIMENT 25

Retroactive Inhibition as a function of Degrees of Similarity

INTRODUCTION:

Among the several conditions of Retroactive Inhibition (R.I.), similarity factor is probably the most widely investigated. Not a single experiment has ever been quoted to refute the fact that R.I. is a function of similarity between the original and interpolated learning. The similarity of the two activities may lie in the material (meaning, association value, spelling etc.) or in the operation performed or as Nagge has shown, in the atmosphere in which the two learnings are done. McGeoch & McDonald (1931) showed that the R.I. tends to increase as similarity develops in the material of original and interpolated learning. Robinson (1927) made an experiment in which the degrees of similarity between the interpolated and original learning were known and he found his hypothesis to be supported. His hypothesis was that "as similarity between interpolation and original memorisation is increased, the amount of R.I. varies directly but up to a point beyond which further increase in the similarity will result a decrease in R.I." Later experiments by Harden (1929), Cheng (1929) and that of Kennelly (1941) confirmed the results obtained by Robinson. But a more recent experiment by Osgood (1946 showed that interference was found to decrease as meaningful similarity among the response members increased. Hamilton (1943) found on the other hand that as the interpolated material became more similar to the original material, there occurred a facilitating effect rather than interfering one.

Thus, this brief review of the different experiments shows that the results are not entirely congruent and the similarity factor seems to be literally a 'paradox'. That similarity is an important factor in retroactive inhibition is supported by all the experiments but the nature of relationship between degrees of similarity and R. I. is still a matter of controversy.

The present experiment is being carried out in the traditional retroaction paradigm to see whether any new light can be thrown on the problem of similarity as influencing retroactive inhibition.

MATERIALS:

1. 4 lists (List A, B, C & D) of 10 Nonsense Syllables each. All of them should be of equal association value.
2. A multiplication sheet.
3. A list of 10 numbers each of 5 digits.
4. A Stopwatch.
5. An exposure device as that described in Experiment No. 23.

PROCEDURE:

1. The experimental paradigm to be followed here is given below :—

	Stage 1	Stage 2	Stage 3	Stage 4
Condition 1 (Similar in Material & Operation.)	Learning List A for 5 trials & Immediate Recall test	Learning List B for 5 mts.	Recall List A	Relearning List A
Condition 2 (Similar in operation only.)	Learning List C for 5 trials & Immediate Recall test	Learning digits for 5 mts.	Recall List C	Relearning List C
Condition 3 (Quite Dissimilar.)	Learning List D for 5 trials & Immediate Recall test.	Doing Multiplication for 5 mts.	Recall List D	Relearning List D

(If the net amount of R. I. is to be found out, a fourth condition should be taken by giving 'S' to learn List E for 5 trials which should be followed by a rest period of 5 mts. during which the subject should be amused with little humours. This is done to check the 'S' from rehearsing the previous learning. After this, the recall for List E should be tested and the number of trials the subject takes to relearn the same list should also be determined.)

2. Learning in all cases is done by the Method of Ordinary Recall. The list for the particular condition is presented visually to the subject one at a time, allowing 2 seconds for each syllables.

3. The subject is seated in a place wherefrom he will have a good view of the aperture. The following instruction is given :—

"You are to observe the syllables as they are exposed. After each of them has been exposed for once, I shall ask you to write them in any order. You will be given 1 minute for recall. 5 such trials will be repeated".

4. In 5 trials, the subject may not memorize all the 10 syllables. So the percentage of learning in 5 trials is determined by an immediate recall test.

5. During learning the interpolated materials (Stage 2), the subject is given as many trials as possible in 5 mts.

6. After the learning of the interpolated task is done for 5 mts., the recall test of the original learning is taken (Stage 3) and then the same list is relearned by the method adopted previously (Stage 4). The difference in the number of trials necessary for relearning the same number of syllables as learned previously in original learning constitutes the saving (The Saving Method).

7. The procedure is the same for all the conditions except that in condition 3, the subject is given a multiplication sheet immediately after the immediate recall test of List D has been taken. 'S' is asked to multiply for 5 mts. after which recall test for List D is made again and the relearning done in the way already stated.

8. The different conditions are to follow each other after a rest pause of 15 mts.

RESULTS :

The results are tabulated in a table like the following :—

Condition	Nature of Interpolated Task	Number of Syllables learned in 5 trials in Stage 1	Percentage * of Recall of original learning (after stage 2)	Extra trials taken to relearn the same percentage as learnt in 5 trials in stage 1	Percentage of trials saved
1	Similar in material and in operation				
2	Similar in operation				
3	Quite Dissimilar				

---

* Percentage in terms of the syllables learnt in 5 trials and not in terms of all the 10 syllables exposed.

Then another table like the following is presented to show the net result.

Difference between conditions	Percentage Recalled after interpolated learning	Percentage of Saving after interpolated learning
1 & 3		
1 & 2		
2 & 3		

DISCUSSIONS :

The questions to be discussed here are :—

(1) Which of the conditions was found yielding the least percentage of Recall and Saving ? Which one the highest ? Are your experimental results in line with the results obtained by other investigators ? Was the retroactive effect maximum when both material and operation of the original task were similar to that of the interpolated task ?

(2) Does the saving method also support your results ?

(3) What light does the present experiment throw on the theories of Retroactive inhibition ? Does it favour the interference theory of Decamp and go against the anti-consolidation theory of Muller and Pilzekar ? Does it support in any way the 'unlearning theory' recently propounded by Melton & Irwin ?

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EXPERIMENT 26

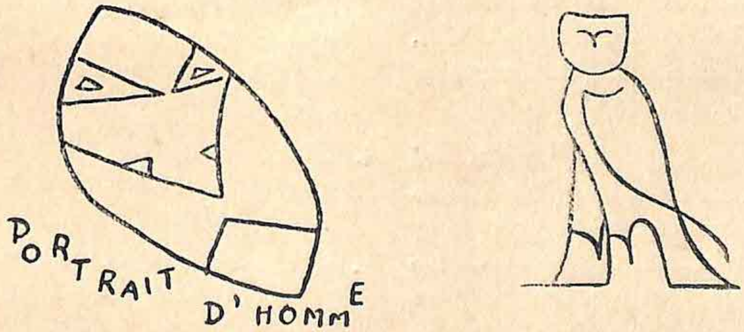
Social Transmission of Visual and Verbal Materials

INTRODUCTION :

Did you ever whisper a sentence to your neighbour who whispered it to his, and so on down the line until the last man repeated something you never dreamt of? Probably such games were first played in the Cambridge Psychological Laboratory when Bartlett studied the social factors influencing our memory. Bartlett saw a close relationship between the changes of an object in rumour-monger and the qualitative changes in memory due to the lapse of time and other factors. He saw the results obtained by the method of successive reproduction (first used by Wolf) also being true when, as in the case of narrative, the picture is passed in a chain fashion, to a number of subjects, each of whom reproduces it from his memory and then shows his reproduction to another. With this 'serial reproduction' method using narratives, Bartlett approached very closely the conditions for true rumours, except that successive versions of the story were written and read rather than being spoken and heard. Changes like 'levelling', 'sharpening','assimilation' etc. were also noted by this method as are found in the decay of individual memory, though to a magnified and accelerated degree.

In one experiment, the original drawing of an owl (used by Bartlett) became a cat at the end when it was transmitted from person to person. Bartlett quotes his own story in which the original primitive drawing of a person (Portrait D'Homme) was shown to one observer who redrew it from memory to show to a second observer, he to a third and so on. Both elaboration and simplification were found on the fifth reproduction in the direction of a schematic form current in the group of subjects. Such a 'conventionalisation' was found to a greater degree when the story entitled "The war of the ghosts" was studied by the method of serial reproduction. Since a number of individuals are involved in such situations, the meaning that emerges is likely to be what is 'common' to the group in question. Some items are thus dropped down (levelling) and some transformed into familiar ones (standardization or assimilation) and still others are accentuated (sharpening). Yet, there is a great effort to mould the remembered material into coherence with its original theme (schematization).

The purpose of the present experiment is to study these qualitative changes in verbal and visual materials using Bartlett's Method of Serial Reproduction.



Drawings reproduced from F.C. Bartlett's *Remembering*, 1932
(By permission of Cambridge Univ. Press, England)

MATERIALS :

1. The story of 'the war of the ghosts' (see below).
2. Two drawings (after Bartlett) as given above.
3. A stop-watch.

The war of the ghosts

(Reproduced from '*Remembering*' by F. C. Bartlett, Cambridge Univ. Press. 1932.)

One night two young men from Egulac went down to the river to hunt seals, and while they were there it became foggy and calm. Then they heard war-cries, and they thought: "May be this is a war-party". They escaped to the shore, and hid behind a log. Now canoes came up, and they heard the noise of paddles, and saw one canoe coming up to them. There were five men in the canoe, and they said :

"What do you think ? We wish to take you along. We are going up the river to make war on the people".

One of the young men said : "I have no arrows".

"Arrows are in the canoe", they said.

"I will not go along. I might be killed. My relatives do not know where I have gone. But you", he said, turning to the other, "may go with them".

So one of the young men went, but the other returned home.

And the warriors went on up the river to a town on the other side of Kalama. The people came down to the water, and they began to fight, and many were killed. But presently the young man heard one of the warriors say : "Quick, let us go home: that Indian has been hit". Now he thought : "Oh, they are ghosts". He did not feel sick, but they said he had been shot.

So the canoes went back to Egulac, and the young man went ashore to his house, and made a fire. And he told every body and said: "Behold I accompanied the ghosts, and we went to fight. Many of our fellows were killed, and many of those who attacked us were killed. They said was hit; and I did not feel sick.

He told it all, and then he became quiet. When the sun rose he fell down. Something black came out of his mouth. His face became contorted. The people jumped up and cried. He was dead.

EXPERIMENTAL PROCEDURE :

The experiment is divided into 2 parts, with a gap of 5 mts. between them. The first part deals with the narrative and the second part with the drawings. At least five or six subjects are asked to volunteer in this group experiment. They are seated in a room adjacent to the laboratory.

Part 1 :

1. One of the subjects is called in the laboratory and the following instruction is given to him :—

   "*This is a test of memory. You will be given a mimeographed copy of a story. Please read it carefully because immediately after you have finished reading, you will be asked to narrate it as accurately as you can to a second subject.*"
2. After the instruction, the subject is given the story to read.
3. Immediately after he has read it, a second subject is called into the room and the first subject narrates to him all that he can remember. The second subject is asked to listen attentively to what the first subject tells. The story narrated by the first subject is recorded verbatim by the experimenter (or any fast writer without the knowledge of the second subject.
4. The first subject then leaves the room and he is asked not to tell anything other subjects.
5. A third is then called into the room who listens carefully to what the second subject narrates. The third subject is similarly asked to narrate to the fourth subject what he heard from the second subject and this procedure continues in the same manner until the last subject has repeated

the story he has heard, to the experimenter who notes it down verbatim. The verbatim records of the subjects are serially numbered.

Part 2 :

The procedure in this part is essentially the same. The subject is shown the two figures one by one, each for 3 seconds. Then he is asked to reproduce them one by one from his memory. The reproductions of the first subject are shown one by one to a second subject who carefully sees them one by one, each for 3 seconds and then reproduces them as accurately as he can., The reproductions of each subject are thus passed to one another in a chain fashion until all the subjects are tested. The reproductions are serially arranged and changes are noted for each subject and for both the drawings.

TREATMENT OF THE DATA :

The following changes are quantified from the reproductions of the drawings :—

1. Lost of Details.
2. New details substituted.
3. Accentuation.
4. Changes towards increasing complexity (complication).
5. Conventionalization (Normalization).
6. No definite change.
7. Right-left reversals.
8. Intra-serial assimilations (confusion of two figures).

The following changes are studied and quantified in the narratives reproduced by the subjects following Bartlett's method :—

1. *Levelling*—The drops of details so as to make the reproduction simpler and more uniform. The experimental material should be divided into (1) Main outlines (2) Specific references including proper names and the omissions are determined as is done by the Method of Retained Member. However, the aim should be to count the meaningful points of the theme that are omitted and not the omissions of the subordinate clauses.
2. *Sharpening*—Accentuationof some features of the original material.
3. *Assimilation*—Simplification and generalization by combining similar items (condensation), modification of details to make them more meaningful. Assimilation is subdivided into :
   - (*a*) *Assimilation to principal theme*—The false items that fit and amplify the principal theme.
   - (*b*) *Good continuation*—The tendency to make the incomplete items complete whether of the original or of the reproductions.
   - (*c*) *Assimilation by condensation*—The economical way of fusing separate items into a single category.
   - (*d*) *Assimilation to expectation (conventionalization)*—Changes of items taking a form that supports the agent's ordinary habit of thought.
   - (*e*) *Assimilation to linguistic habits*—(Stereotyping).

DISCUSSIONS :

1. Discuss from the protocols how well was the theme of the story retained? How does it differ from the changes in the theme of the visual materials ?
2. What details of the theme were retained and what details omitted ? What social factors were found influencing the omission and addition ?
3. What items were mostly sharpened both in visual and verbal materials ?
4. Present the relevant protocols to show how assimilation took place.
5. Make a comparative study in the changes of verbal and visual materials.
6. How do you account for these changes ?

Does the stimulus factor which the Gestaltists emphasise so much play any role here ? Describe the role of culture, attitude and other motivational factors in the change.

7. What light can you throw from your results on the development of rumours, myths and legends ?

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2. Allport, G. W. and Postman, Leo—*The Psychology of Rumour.*
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EXPERIMENT 27

Reaction Time as a function of Task Complexity

INTRODUCTION :

Most of our reactions in life are not like the simple reaction with its single stimulus and single response. It is seldom that we are so sure of what is going to happen that we can be definitely prepared to react automatically at maximum speed. At least a bit uncertainty as to what is going to occur, exists almost always. For example, the motorist does not know which traffic light will be turned on or off at the crossing when he will pass. If he drives too rapidly, he must check his speed at the spot to discriminate which of the lights is being flashed. If he sees the green light, he speeds the car again and if red, brakes the car to a dead stop. This reaction according to the two lights is not as simple as that of starting a race at the sound of the pistol shot. The former reaction is called Choice Reaction and the latter Simple Reaction. Even in the race, if the instruction is to start only at the sound of a pistol and not at an auto-back firing, it becomes difficult for the racer to give as nice a start as when he is instructed to start at any sound. He must 'discriminate' before he starts and this is a situation complex to him.

In the laboratory, such situations may be produced for example by instructing the subject to react only to a red light when both red and white signals are used in a haphazard order. The necessity of recognizing the correct signal increases the average reaction-time above the time of simple reaction. The Reaction time found in such situations is called the Discrimination R.T. With Choice R.T., the situation is made more complicated. Here is required a choice between two or more reactions as well as a discrimination between the stimuli. The subject may, for example, be instructed to respond with the right hand if the light is red and with left hand if the light is green. Or, if he is instructed to respond with the right hand when the red light appears on the right of the green and with the left hand if the *stimuli* are reversed, the reaction time will increase still more.

From these, we can formulate the hypothesis that other conditions being equal, the more the complicated the task becomes which the subject is given to do, the greater will be his R. T.

The purpose of the present experiment is to verify the above stated hypothesis.

APPARATUS :

(1) Hipp Chronoscope (Fig. 17)
(2) 5-Volt Battery and wiring accessories.
(3) 2 Torch Bulbs (Red & white) with wires soldered on it.
(4) Mercury commutator.
(5) 1 simple spring key.

(6) 1 Make & Break key.

(7) A Plug-key (Double-throw switch).

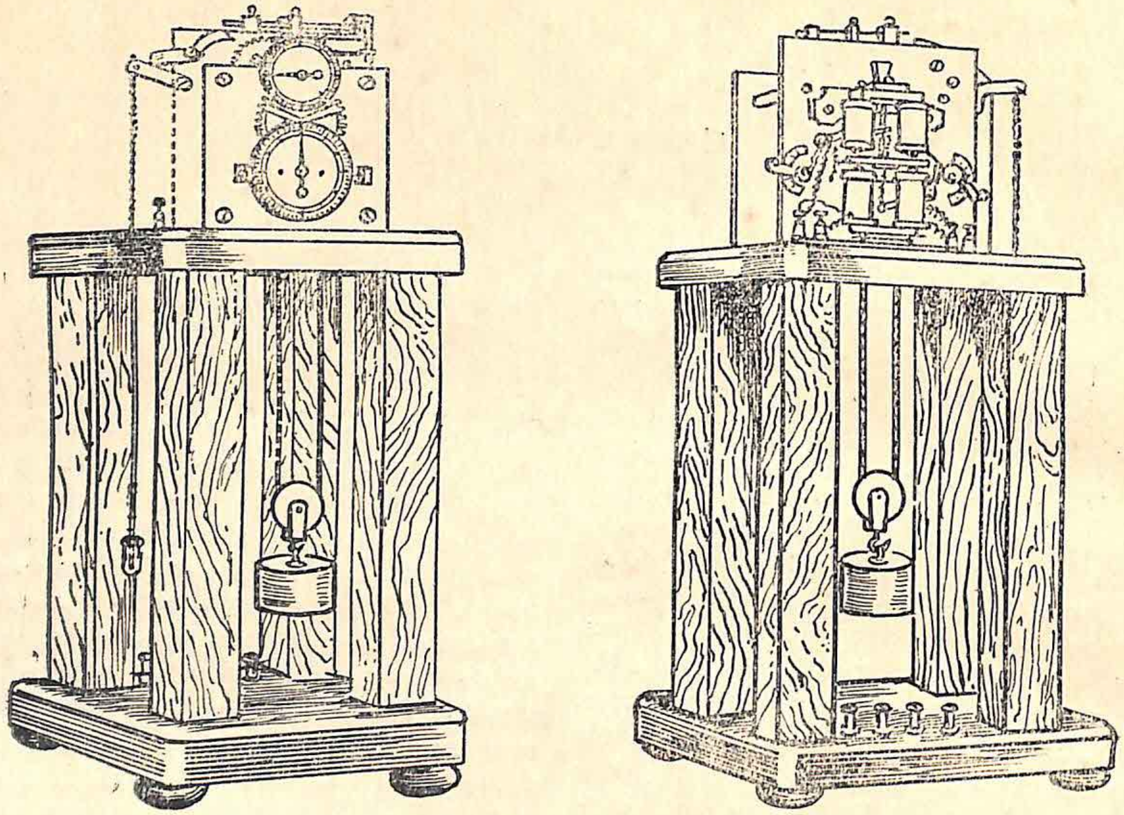

Fig. 17 showing Front & Back views of Hipp Chronoscope

DESCRIPTION & ADJUSTMENT OF THE HIPP CHRONOSCOPE

(For details see C. S. Myer's *Text Book of Experimental Psychology*).

The Hipp Chronoscope has a clockwork driven by a weight and governed by a metal spring (lamella) which is so tuned as to oscillate 1000 times per second. The quickest wheel of the clock moves the distance of one tooth further every time the spring jumps upwards. Thus, it allows the wheel to advance precisely one tooth further every thousand of a second (millisecond). The little indicator of the upper clock-face is connected to this wheel. Each movement of this indicator denotes, therefore, a thousand of a second. The lower clock, larger in size than the upper clock, is also divided into 100 divisions like the upper one but the pointer revolves round the dial once every 10 second. Thus, each unit denotes 1/10 of a second or 100 m.s.

The clock of the chronoscope is started by pressing the key on the top and is stopped by pressing the other key lying at the back of the former key. (For convenience, two cords are tied with the pressing keys and the chronoscope can be set in motion or stopped by pulling the two cords).

Before the experiment, the pointers of the clocks are set at zero.

EXPERIMENTAL PROCEDURE :

1. The whole apparatus is so arranged that when the experimenter presses the simple key, one of the lights is seen and the chronoscope starts simultaneously. The chronoscope is stopped as soon as the

subject presses his key. (see Wiring Diagram, Fig. 18)

2. The subject is seated comfortably before the Make & Break Key and the two bulbs are kept before him. Precaution is taken to see that the Record sheet, the Plug-Key and the Experimenter's Key are placed out of S's sight.

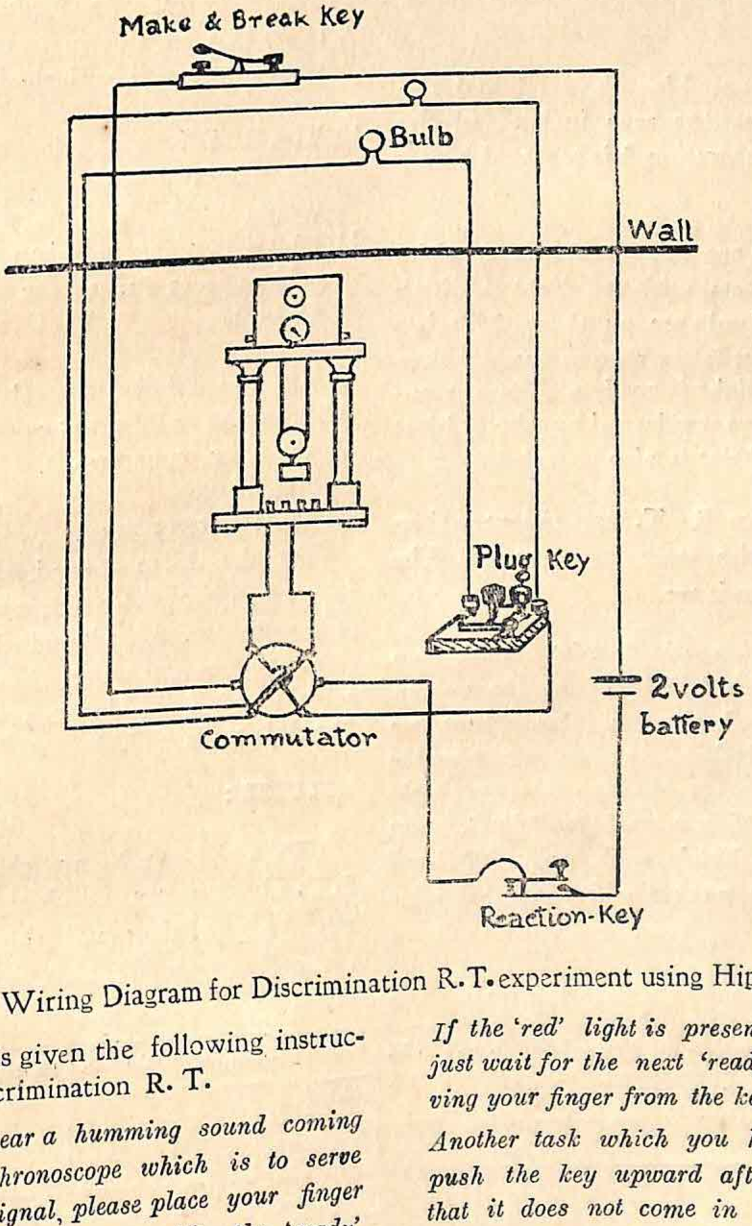

Fig. 18 showing Wiring Diagram for Discrimination R.T. experiment using Hipp Chronoscope.

3. The subject is given the following instructions for Discrimination R. T.

"When you hear a humming sound coming out of the chronoscope which is to serve as a 'ready' signal, please place your finger lightly on the reaction key. After the 'ready' signal has been given, I shall flash either of the bulbs. You are to react only when you see the white bulb. Don't react when the 'red' bulb is flashed. Its purpose is to trick you into making a false move. As soon as yousee the 'white' light, press the key. If the 'red' light is presented, don't press, just wait for the next 'ready' signal removing your finger from the key.

Another task which you have to do is to push the key upward after each trial so that it does not come in contact with the terminal at the bottom."

4. 5 practice trials are given to 'S' before the actual experiment takes place. The experimenter starts the chronoscope by pressing its switch and the chronoscope begins to produce a humming sound.

This sound acts as the ready signal. The fore-period (5 seconds) is kept approximately constant throughout the whole experiment, after which the Experimenter presses his key and the subject responding accordingly.

5. The R. T. is noted for the trial and the pointers adjusted at zero in both of the clocks. This operation * is repeated before every trial.

6. 25 such trials are taken with the white light, but 10 tests with red light is distributed so randomly among these 25 trials that the subject is not able to guess when the stimulus light is coming. The percentage of success evidenced by the subject in this 'catch' test is also recorded.

7. The Choice R. T. experiment is then started with the same arrangements. The instruction here is :—

> "*When you hear the 'ready' signal, keep your fingers of both the hands on the wooden platform beneath the key. One of the two bulbs will be flashed. As soon as you see the 'white' light, press the key with your right hand finger. If you see the 'red' light, press the key immediately with your left hand finger. Please push the key upward after each trial*".

8. 5 practice trials are given to acquaint the subject with the above operations instructed to him.

9. 25 trials with 'white' light and 25 with 'red' light each randomly distributed are taken so that the subject may not guess which light will be flashed.

10. The R. T. for each trial and the percentage of erroneous reactions made by the subject, if any, is noted in the way already stated.

11. 25 trial are again taken by making the subject recapitulate the instructions for Discrimination R. T.

Thus a total of 100 trials are taken in the ABBA order as follows :—

25 Discriminatory.
50 Choice.
25 Discriminatory.

As already mentioned, the ABBA order is used when the practice and fatigue effects are to be neutralised and the order of the different experimental conditions is to be counterbalanced (cf. Underwood's ***Experimental Psychology***. Page 30)

RESULTS :

The chief results are the mean R. T., its S. D. & Coefficient of Variation for each of the two conditions and the reliability of difference between the two mean R. T's. They are to be tabulated in the following way:—

Condition	Mean R.T.	S. D.	C. V.	σ M	σ Differ.	't' ratio	Probability level
Discrimination							
Choice							

DISCUSSIONS :

The following questions should be answered with reference to the results obtained :—

(1) Which condition yielded the fastest reaction ? Is this result in conformity with your hypothesis? Is the difference between the two means of the different conditions statistically significant ? (mention the 't' ratio and the significance level.)

(2) Is there any evidence that fatigue or practice influenced your results ? Quote the relevant data.

---

* If this operation is felt inconvenient, 'E' may continue the next trial without adjusting the pointers at zero and by a subtracting process, the R. T. for the trial is calculated.

(3) List the chief theoretical & practical uses of Reaction time techniques, basing the list upon what you find in your readings.

REFERENCES :

1. Woodworth, R. S.—***Experimental Psychology***, 1938 Edn., Chap. XIV.

2. Myers, C.—***Text-book of Experimental Psychology***, Part I, Chapter II.

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EXPERIMENT 28

Effect of Mass & Distributed Rest Pause in Muscular Work

INTRODUCTION:

It is a common observation that a rest pause is highly favourable if introduced in the middle of a continuous work period and this has been verified long ago both in laboratory and in industry. Mosso, the pioneer in the study of muscular fatigue, found that continuous pull of a load of 6 kilogram with the middle finger of one hand in Ergograph for 1 minute, set such a fatigue in the subject that it took rest pause not less than 2 hours to bring full recuperation. When a rest pause of 10 seconds was given after each continuous contraction, the same load could be pulled continuously without any fatigue. The subject could continue lifting the weight for an indefinite period.

Observations in actual business concern and in industry have pointed in the same direction. In one English shoe factory where the work of heavy cutting presses was done by two girls continuously throughout the day, the weekly output of the plant was 42 gross in a 46 hours week. When at the advice of psychologists, a rest pause of 20 minutes was given after each 40 mts. work, the weekly output raised to 49 gross in a 30 hours week. Thus, the rest pause in manual work has been found most beneficial and the introduction of systematic rest pauses has subsequently been the subject of much study in the laboratory, specially employing Ergograph.

A rest pause of too longer duration should have been according to commonsense most beneficial but researches in the optimal programme of rest schedule have shown that the 'most favourable rest pause' should be neither too long nor too short. It is for this reason perhaps that a massed rest pause of a certain length is not so beneficial as when the same amount of pause is distributed in different spells of work.

The present experiment is designed to make an Ergographic study of the variation in the amount of work done with different distribution of work and rest periods.

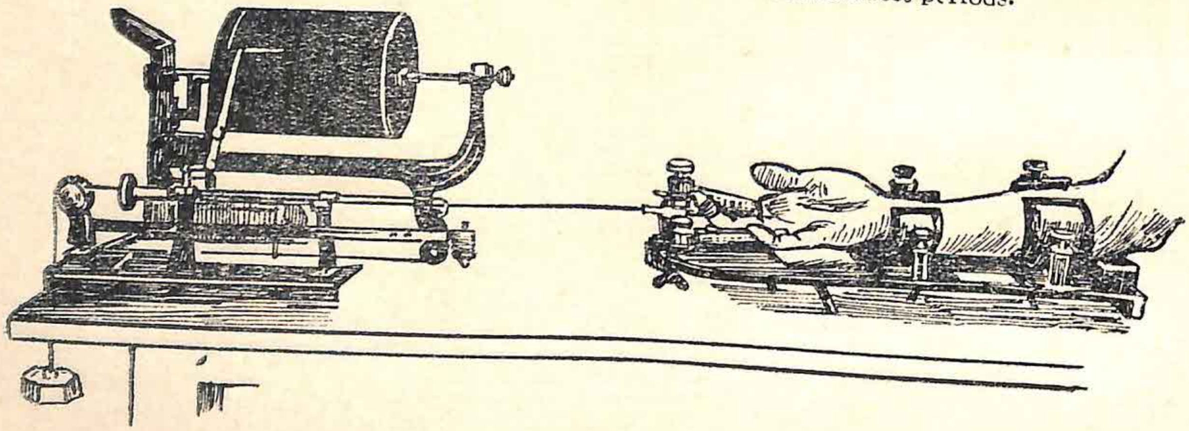

Fig. 19. A Mosso Ergograph.
(Manufactured by the Technical Corporation, Lucknow)

APPARATUS & MATERIALS :

1. A Mosso Ergograph (Fig. 19)
2. A Metronome.
3. A Kymograph (with a speed of 1 revolution per 4 mts.)
4. Cotton.

PROCEDURE :

1. The subject's right arm is placed in the arm rest in which it is clamped.
2. His forefinger and third finger are inserted into the finger caps beneath which some cotton should be placed and the fingers are pushed into it as far as they go. Then the fingers are clamped in this state.
3. The loop attached to the weight is placed on the terminal joint of the middle finger and it is seen that the finger is as nearly straight as possible so that in flexing the finger the weight moves through as large a distance as possible.
4. The subject is now given some practice trials to make him familiar with the work keeping time with the beat of the metronome. The metronome is adjusted at 60 and the lever of the bell set at 2, so that the metronome can beat seconds with a bell at every second beat.
5. The subject is instructed as follows:—
   "*Pull the string with your middle finger as strongly as you can. Pull when the metronome gives a bell and then release the string without leaving it from the finger as soon as the metronome gives a tick without any bell. Go on pulling every time as strongly as you can till I ask you to stop. Keep pace with the rhythm of the metronome. Remember, you will have to pull the string when the bell rings and let the string go to its own place as soon as the metronome gives a tick. When I will say 'ready', you have to start*".
6. The next step is to determine a suitable weight for the subject. This should be a weight of such a magnitude that 'S' can lift about 30 times successively, without a very definite degree of muscular fatigue being shown. (For a healthy young man a weight of 2·5 Kilogram is generally found suitable.) If the subject has worked previously in the Ergograph, then without any further 'try-out' a suitable weight can be guessed from the previous Ergogram.
7. After a rest pause of 10 mts., (in case if the suitable weight is determined after 3 or more attempts then a rest pause of 20 mts. should be given which is likely to dissipate the subject's fatigue) the experiment proper is carried out in which 3 successive sessions (conditions) follow each other by a rest pause not less than 15 mts. The work to be done in each session is 30 lifts, one pull in every 2 seconds and the total rest period for each condition may be scheduled for 4 minutes. The work and rest periods are to be distributed differently for different sessions as presented in the following table :—

Session or Condition	Total work	Number of distribution of the work period	No. of distribution of the rest period.	Successive stages of work & rest
1	30 lifts	Two	One	15 lifts-4 mts. rest-15 lifts.
2	30 lifts	Three	Two	10 lifts-2 mts.-10 lifts-2 mts.-10 lifts.
3	30 lifts	Five	Four	6 pulls-1 mt. -6 pulls-1 mt. -6 pulls -1 mt.-6 pulls-1 mt. -6 pulls,

Thus, according to the above schedule, 15 lifts are followed in first session by 4mts. rest and then 'S' pulls for 15 times. In second session, 10 lifts are followed by a rest pause of 2 mts. 'S' again gives 10 pulls, then receives 2 mts. rest and again pulls for 10 times. In the third session, 'S' has to give 6 pulls which is followed by 1 minute's rest, then again he gives 6 pulls and gets 1 mt's rest and so on till all the 30 lifts are completed in this way.

Great caution is taken to see that the subject's finger is not injured. After completion of each session, the subject's arm should be made free from the arm rest and he is allowed to relax at his own will.

8. When all the successive sessions are over, relevant information are written on the smoked paper and it is put in the shellac solution. The record is then taken out and dried.

RESULTS :

The height of each of the contractions recorded on the smoked paper is measured on a Centimeter Scale and they are then converted into Dynes by the following formula :—

Dyne=Height of the contraction in cms. × Weight in grams pulled. (Multiply by 1000 to convert kilograms into grams.)

The Dyne obtained is then converted again into Erg by multiplying it with the constant 981. The raw data are then tabulated as follows :—

Session	Total Erg of the first 15 pulls.	Total Erg of the last 15 pulls	Erg difference between the first and last 15 pulls	Total work done (Total Erg of all the pulls made after and before rest pause)
1				
2				
3				
Difference between 2 & 1				
Difference between 3 & 2				

DISCUSSIONS :

Questions of the following nature should be discussed :—

1. From the results obtained, determine which session's total work was the greatest and which the least? Do the results support the efficacy of distributed rest pause and work periods over the undistributed ones?
2. Can you develop the hypothesis from your results that the influence (efficacy) of rest and work periods directly vary with their length of distributions? Present the relevant data.
3. How do you explain your results? Is the cause mainly physiological? Describe how rest pause influences psychologically as well as physiologically to dissipate the fatigue. Is muscular fatigue really physiological in character?

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3. Myers, C. S.—*A Text Book of Experimental Psychology*, Part 1, Chapt.-XIV.
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EXPERIMENT 29

Pneumographic study of Emotion

INTRODUCTION :

One of the marked physiological concomitants during emotion is the change occurring in respiratory system. Respiration is reflex-automatic mechanism which serves as a metabolic function. It is very sensitive to any stimulus which causes a momentary arrest of breath or which causes rapid breathing in excess of the metabolic needs. If the former happens then it will usually be followed by a compensatory increase of breathing and if latter then by a compensatory reduction of breathing (Woodworth, 1938).

There are two phases in respiration. They are inspiration and expiration. Inspiration is the process of inhaling air in the lungs and expiration is giving out the inhaled air from the lungs. By means of a sensitive Pneumograph, these two phases can be recorded with marked accuracy.

The main measures in a respiratory curve during emotion are the changes in rate and amplitude. It has been found more than often that during excitement, breathing tends to be fast and deep, while during depression, it tends to be slow and the depth remains normal. Respiratory curves during pleasant and unpleasant experiences do not differ at all. Both show either increased or decreased rate but usually increased. Skagg (1930) found that after a shock or surprise, the rate was high and the depth nearly normal and the breathing irregular.

The present experiment is designed to study the respiratory curves of the subject during an emotional state presumed to occur immediately after sensory excitation by stimuli like Pistol-shot, mild electric shock and taste of Quinine tablet.

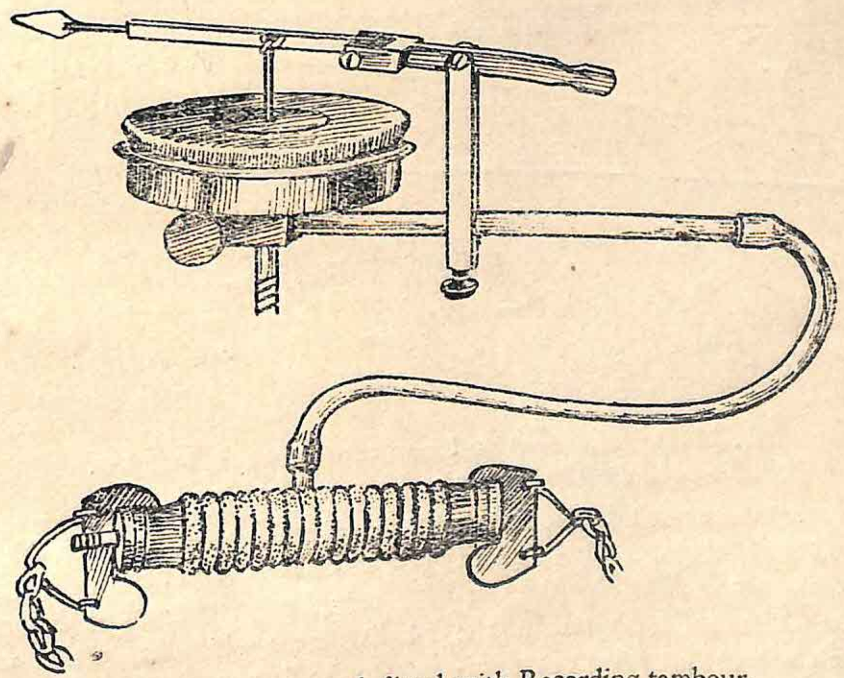

Fig. 20 A Pneumograph fitted with Recording tambour.
(Manufactured by the Technical Corporation, Lucknow)

MATERIALS :

1. A Pneumograph (Fig. 20)
2. A Kymograph to accommodate a long strip of paper. (Fig. 21)
3. A Chronometer.
4. A stop-watch.
5. A Marey Recording Tambour, (Fig. 20)
6. A Shock Apparatus.
7. A pistol (Toy pistol making intense sound will equally do).
8. Few Quinine tablets.
9. A 3-stylus Electromagnetic Time marker.
10. Three Reaction-Keys (A multiple key with 3 pairs of separate terminals is more convenient)
11. A 5-Volt Battery.

PROCEDURE :

1. The subject is seated comfortably in a quiet place and is asked to relax after the elastic belt has been wrapped firmly but not too tightly on that part of the body such as heart, stomach or abdomen which gives satisfactory inspiration and expiration curves.
2. The Recording drum is then adjusted in such a way that both the stylus of the tambour and lever of the chronometer give a smooth record throughout.
3. The three keys are connected in such a way through the battery to the different terminals of the Time Marker (See Fig. 21) that with the pressing of the key, its respective stylus are moved up and down. This is done to register the sequence of application of the different stimuli. The Shock Apparatus is also connected with one of the Keys in such a way that when the particular key is pressed then only the 'S' receives a mild shock on his right palm and at the same time the sequence of this stimulus is registered on the smoked paper.

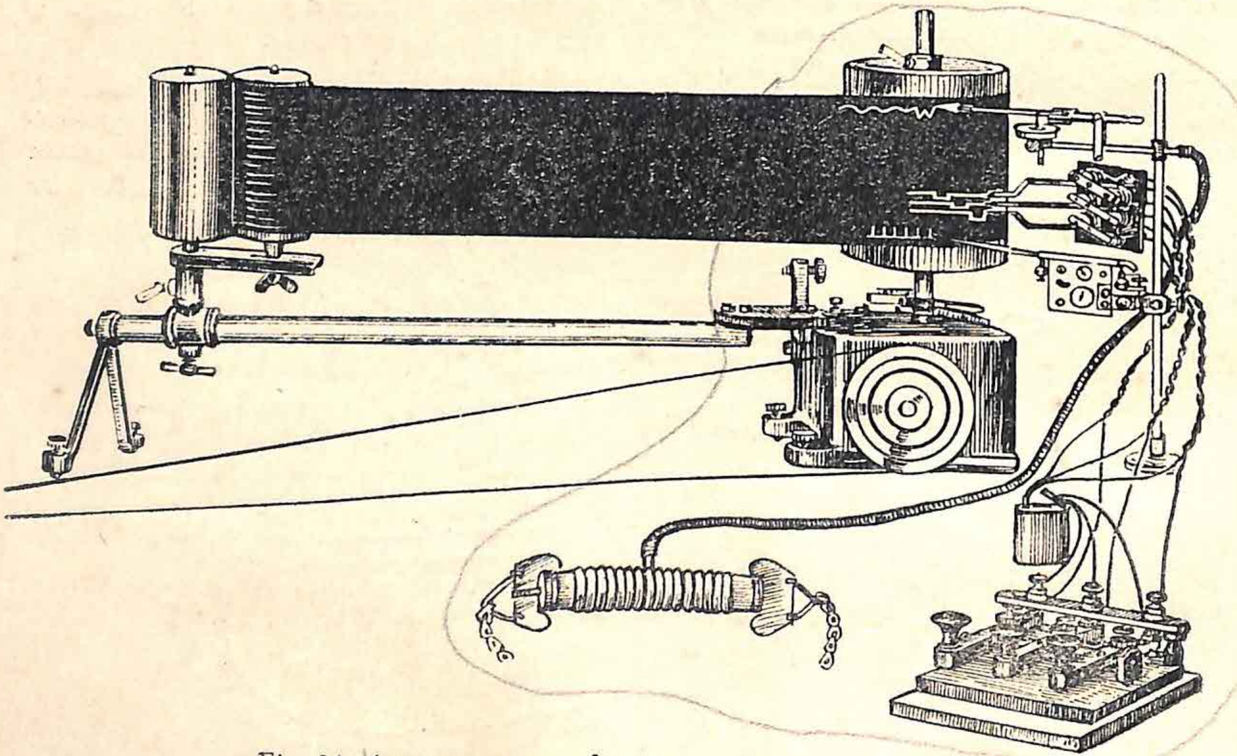

Fig. 21 Apparatus set up for an experiment on Emotion.
(To be had of TheTechnical Corporation, Lucknow)

4. After the subject has seated with his back to the Kymograph (which unables him to see the record) for a few minutes, the

smoked cylinder is moved at the rate of one revolution per 3 secds. A normal respiratory curve of the subject is then taken for 1 minute.

5. The curve is examined to see whether downward thrust of the tracing records inspiration or expiration.
6. Immediately after 1 minute, any one of the stimuli is given to the subject for a very brief time, and its respective key pressed to register the administration.
7. The stimuli are given in a random order.
8. The stimuli follow each other by 1 minute.
9. The respiratory curve is taken for a total duration of 12 minutes; thus each stimulus can be administered at least thrice and the sequence of application is registered on the smoked drum.
10. The smoked paper is then taken out of the kymograph after all necessary information are written on it before t is varnished.

RESULTS :

The base of each of the cycles is joined by a straight line on which the amplitudes for each are drawn by putting a perpendicular from the vertex of the cycle to its base line. These are done to get the following measures:-

1. Amplitude for all the cycles of normal respiratory curve taken for 30 secds. before the introduction of the stimuli and their average.
2. Inspiration/Expiration Ratio of the above (cf. Woodworth's *Experimental Psychology*, page 262)
3. Mean Amplitude of all the cycles taken for 30 secds. immediately after the first introduction of a particular stimulus. The same is determined for all the three stimuli.
4. The net result is tabulated in a table like the following :—

Stimulus	Mean No. of Cycles taken in 30 secds. under different conditions	Average duration of each cycle.	Average amplitude immediately after first stimulation	I/E ratio	I fraction
Normal					
Shock					
Quinine					
Pistol-shot					

DISCUSSIONS :

The following questions should be answered :—

1. How do the rate and amplitude of respiratory curve differ during various emotional states followed by sensory excitation as compared to the rate and amplitude for the normal respiratory curve ? Does the difference seem to be statistically significant ? How the I/E ratios differ from each other ?
2. How do the respiratory curves obtained after the different types of sensory excitation vary among themselves ? Do they suggest that each stimulus yielded a different type of emotional reaction ?
3. What evidences do you have that your experiment really studied the state of emotion under laboratory condition ? Do you think that a state of surprise occurred immediately after the pistol shot ? Suggest some better arrangements to create a real surprising situation in the laboratory which can be studied with Pneumograph.

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3. Valentine, W. L.—*Readings in Experimental Psycholgy*, pp. 159-178.

EXPERIMENT 30

Knowledge of Results as an Incentive

INTRODUCTION:

In schools or in factories, knowledge of results can serve as an impetus to pupils and men to reach a higher and better goal. It will improve their efficiency as a whole and their accuracy of performance in particular. This is a matter of common observation and can very well be verified in our day-to-day experience. A number of experiments has been reported by various writers in which knowledge of results was used as an incentive. For instance, the experiments of Arps (1917) on ergographic work, of Crawley (1926) upon work done with the arm and leg muscles, of Johnson (1922) upon Reaction-time and of Book & Norvell (1922) involving different kinds of activity, popular among which is that of writing clearly as many 'a' as could be accomplished in 30 seconds. The experiment of Elwell and Grindley (1938) demonstrated that some motor skills are difficult to acquire unless the subject has som knowledge of his performances. In many oef Thorndike's experiment on human learning, the subject has been placed in a situation in which he can make any one of a number of discrete responses and has then been told whether his response was 'right' or 'wrong'. Thorndike has studied in detail the way in which knowledge that a person is 'right' seems to act in very much the same way as a 'reward' is-supposed to act in experiments on learning with animals. In the other experiments which have been referred to, knowledge of results seems to act in rather a different way. It seems to act as an incentive to greater effort rather than as a selective influence leading to one specific response in preference to another. The present experiment is also designed to study the effect of knowledge of results as an incentive factor in performance of a simple task, e. g. to draw a 3 - inch line with eyes closed in one stroke.

MATERIALS :

1. Paper and Pencil.
5. A Centimeter Scale.
3. A Screen.
4. An opaque glass to blindfold the subject.

PROCEDURE :

1. The subject is seated comfortably by the side of a table. A foolscap paper and a pencil are placed before him.
2. The length that covers 3 inches is shown to the subject for one minute and the following instruction is given to him:— *"You have to draw a 3-inch line with your eyes closed in one stroke and you have to return to the same point from where you started. Any deviation from the required length will be counted as an error and the inaccuracy which you show in reaching the same starting point will also be noted each time. The total amount of error will be the length of these two kinds of deviation. Some 40 trials will be given altogether.*
3. The subject takes his position at the starting point and draws the line in one stroke with his eyes closed, stopping when he thinks he has reached the required length and then again returns and stops at a place which he believes to be the starting point. The error shown by the subject is measured after each trial and the subject opens his eyes only when his performance has been shielded from his vision. 10 such trials are

repeated. These ten trials comprise the first series of the 'without knowledge' condition.

4. From the 11th trial, the same procedure is followed upto the 30th trial but with the exception that the 'S' is allowed to see his performance after each trial and he is given to measure the errors done in the trial. The deviations shown by 'S' in drawing the required length of 3 inches and the discrepancies in returning to the starting point are measured in millimeter scale and they are recorded as total amount of error. The direction of error is also recorded for each trial to indicate whether the 'S' drew more than the required length (overshooting) or lesser than that (undershooting). The twenty trials repeated following the above procedure constitute the 'with knowledge' condition of the experiment.
5. In the last 10 trials, again the 'S' receives no knowledge of his performances. Thus, the procedure to be followed here is just the same as that of the first 10 trials. In this series also, the subject is given no chance of knowing how he performed in the immediately preceding trial.
6. Thus, the different series of trials are sequenced in the following ABBA order.
   (1) 10 trials without knowledge of results (condition 1a).
   (2) 10 trials with knowledge of results (condition 2a).
   (3) 10 trials with knowledge of results (condition 2b).
   (4) 10 trials without knowledge of results (condition 1b)
7. After all the 40 readings are taken, the subject is asked to give his introspection for each of the 4 series of the experiment.
8. The errors not measured in 'without knowledge' series are then measured by the experimenter for each of the trials.

RESULTS :

The total amount of error for each trial should be tabulated as follows to provide at the same time a report of 'overshooting' and 'undershooting'.

Trials	Condition 1a		Condition 2a		Condition 2b		Condition 1b	
	+	−	+	−	+	−	+	−
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

The following statistics should be calculated from the raw data thus tabulated.

1. Average Overshooting and Undershooting for each of the 4 Series.
2. Average Overshooting and Undershooting for both conditions.
3. Average Absolute Error (neglecting algebraic signs) for both conditions.
4. Standard Deviation of the Absolute Errors for both conditions.
5. Reliability of the difference between the two Average Errors.

The above statistics should be then presented in a table like the following :—

Condition	Average Over shooting	Average Undershooting	Average Error	S.D.	σ M	σ Diff.	't' ratio	Probability
With knowledge								
Without knowledge								

DISCUSSIONS :

The following questions should be answered :—

1. Is the 'with knowledge condition' more facilitating than the 'without knowledge' condition ? Is the difference between the Average Errors for the two conditions statistically significant ? (Mention 't' ratio and its probability level).
2. Do you find from your experiment that knowledge of results acts as an incentive ? How does the introspective report of your subject stand in support of this ?
3. Discuss with reference to your results how the introduction or the removal of knowledge influences the performance ? Is there any significant deterioration in the performance when the subject is deprived of the knowledge during the last 10 trials ? How do you explain this result ?
4. Can you regard knowledge of results as acting in your experiment similarly to a 'reward' condition in animal learning ? If so, can you explain your findings in terms of Thorndikes 'Law of Effect' ? [Hints :— The Law of Effect can explain this and requires no considerable modification provided (a) there is a significant deterioration in the performance of last 10 trials with the removal of knowledge and (b) there operates no 'directive effect' of the knowledge of result. (The tendency to correct in the appropriate direction any unsuccessful action which has just been made is called by Grindley as the 'directive effect')]

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2. Elwell, J.L. and Grindley, G. C.—"Knowledge of results on learning and performance"—*Brit. Jour. of Psychol.,* (General) (1938), Vol-29 (Quoted by Munn in *Psychology,* Page 131).
3. Thorndike, E. L.—(a) *Human learning,* (b) *The Fundamentals of Learning.*
4. Macpherson, S. J., Dees, V. and Grindley, G C.—The effect of knowledge of results on learning and performance—some characteristics of very simple skills", *Quart. Jour. Exptl. Psychol.,* 1941, Vol-1, Page--68.
5. Woodworth, R. S. & Scholosberg, H.—*Experimental Psychology* (1954), Page 686-688.

APPENDIX

Data on Apparatus

Experiment 1. *Mapping out Touch Spots.*

The wooden skewer and grid stamps may be made to order from any local dealer. If boar's bristles are not available, bristles from a coarse brush may be used. An excellent skewer prepared by Aero Voice, Bari Road, Patna—4, is sold for Rs. 10/- only.

Experiment 2. *Mapping out Cold and Warm Spots.*

Metal cones may be obtained from Aero Voice, Patna—4 within Rs. 5/- each. Heat Spot Tester may be had from Aero Voice, Patna or Purohit & Purohit, Poona for Rs. 8/- each.

Experiment 3. *Mapping out Pain & Pressure Spots.*

Both Von Frey's Hair Aesthesiometer & Algometer with graduated scale (E. P. 1143) can be obtained from The Technical Corporation at about Rs. 20/- and Rs. 50/- respectively. Simple Hair Aesthesiometer can also be locally prepared within Rs. 12/-

Experiment 4. *Errors in Cutaneous Localization.*

All materials for this experiment are available in any stationery shop.

Experiment 5. *Mapping out the Blind Spot.*

An excellent Campimeter including colours, carriers and eye-piece, is prepared by Marietta Apparatus Company, Marietta, Ohio, U.S.A. (Cat. No. II-1-40 A). Since it is too costly (about Rs. 650/-), one may obtain a Campimeter at a cheaper rate from Aero Voice, Bari Road, Patna-4 at around Rs 35/- only A spirit level is obtainable from any dealer of scientific goods.

Experiment 6. *Mapping out Retinal Zones.*

A Perimeter including colour stick as that shown in Fig. 5 is obtainable from Aero Voice, Patna-4 for Rs. 75/-. A Hand Perimeter manufactured by The Technical Corporation very similar to Baird & Tatlock (London) design is also an excellent substitute. It can be obtained along with 5 colour targets directly from the Technical Corporation Ltd.,Sarojini Nagar, Lucknow for Rs 75/- only.

Experiment 7. *The After.Effects of Retinal Stimulation.*

A set of Red, Green, Blue and Yellow Slides is obtainable from Messrs. C, H. Stoelting & Co. (Cat. No. 45330) at around Rs. 25/- A projection lantern can be had of any dealer in scientific goods.

A 200 – watt lamp with a long straight filament can be purchased from any big electrical shop.

A stop-watch for this and later experiments may be obtained from Messrs. Adair Dutt & Co., the price ranging from Rs. 100/- to Rs. 150/-. The Anglo-Swiss Watch Company also supplies a stop-watch for Rs. 75/- only. Jacquet's Pocket Stop-watch capable of reading up to 1/100 of a second is available from Gordhandas Desai & Co. around Rs. 150/- each.

Other materials may be locally made.

If Hearing After Image Apparatus is desired for, it can be had of M/s. The Scientific Apparatus & Chemical Works for Rs. 240/- each which includes the cost of colour cards.

Experiment 8 *D. L. for Lifted Weights.*

The Aero Voice sells 4 sets of weight Rs. 128/- each. The best Metronome though not always available here, is a Stoelting make (Cat. No. 20107) obtainable for $ 10. Metronomes made by Baird & Tatlock Co., London, International Radio Company (Bombay) and the Aero Voice, Patna may prove equally good. Aero Voice sells it for Rs. 128/- each. Purohit & Purohit sells one French make Metronome for Rs 125/-.

Experiment 9. *Differentiation of Visual Extent.*

Galton Bar manufactured by Stoelting (Cat. No. 36021) is not always available here which now costs not less than Rs. 400/-. Aero Voice has prepared a good and usable model after Stoelting and sells it for Rs. 35/- only. A chin-rest may be locally prepared within Rs. 5/- on the lines suggested by Bugleski.

Experiment 10. *R. L. For Grey.*

Electric Colour Mixers prepared by C. F. Palmers (Cat. No. W 265) or Marietta (Cat. No. II-1-30) or by Stoelting (Cat. No. 12610) would cost no less than Rs. 350/- each. The Technical Corporation has prepared equally superior apparatus as that shown in Fig. 8 (EP-1062) and sells it for Rs. 225/- only.

White and Black discs may be locally prepared.

Experiment 11. *R. L. For Two point Sensation.*

Jastrow's modified Esthesiometer as that shown in Fig. 9 (Stoelting Model) is obtainable from the Aero Voice, at around Rs. 65/-. Bengal Chemical sells the same model for Rs. 80/- each. The Technical Corporation has also prepared one Carroll's Esthesiometer (EP-1136) which would cost about Rs. 30/- each.

Experiment 12. *Study of Colour Preference.*

The Cardboard referred to can be locally prepared. Colour Cards of 7 shades may be prepared from coloured papers bought locally. Or it may be available from the Aero Voice, Patna for Rs 35/-. A shutter device which can expose two cards at a time has been prepared by Aero Voice and is sold for Rs 35/- only. Anand Agency has prepared a very handy wooden wheel which conveniently exposes the colour cards and sells it for Rs. 30/- each.

Experiment 13. *Perception of Filled & Unfilled Time Interval.*

An excellent Electromagnetic Sound Hammer may be obtained from C. F. Palmers, London (Cat. No. W220) at a cost around £ 5. Orders for the Electric Stop Watch for the purpose of this experiment may be placed with James Jacquet. A foreign make Time Sense Apparatus (Zimmermann model) may be avilable for Rs. 2370/- from the Artico. Anand Agency has prepared one Time Sense Apparatus which is sold for Rs. 700/- each.

Spring keys are available from the Technical Corporation (EP-130) for Rs. 6/- only. An Electric buzzer, 10—volt battery and wires may be locally available from any Electric Stores.

Experiment 14. *Fluctuation of Reversible Figures.*

The best Kymograph, electrically driven, is a Palmer's make Brodie Starling Kymograph (Cat. No. A 1) that cost nearly Rs. 5300/- This includes gear box, Double Time marker, Manometer, Smoking accessories etc. Orders for this accompanied by an Import Licence are entertained by Gordhandas Desai & Co. and Doctor & Co., Bombay. Palmer's Electrical Recording Drum as that shown in Fig.—14 is obtainable for Rs 500/- approximately from the above. An inexpensive, yet excellent electrically driven multi-speed Recording Drum may be obtained from The Technical Corporation (EP—125) for Rs. 650/- only. Electric Kymographs made by Baird and Tatlock and by Harvard Apparatus Company are also very satisfactory. Jacquet's clockwork Kymograph (No. 1113) is obtainable from Doctor & Co. for Rs. 2100/- approximately. Glazed Kymograph paper roll of 50 m.ms. wide & 110 yds. long is available from Gordhandas Desai & Co. for Rs. 35/- for each roll. Kerosene Burner with 3 inches wick (EP. 165), Smoking stand (EP. 160), Adjustable Stand (EP. 203), Small Clamps (EP. 232). X-blocks of 3/8 of an inch diameter (EP. 237), Varnishing Tray—Foot lever type (EP. 184) are obtainable from The Technical Corporation at a reasonable rate.

The Technical Corporation has also prepared an excellent Electromagnetic Stylus with double magnet (EP. 279) after Palmer and sells it for Rs. 20/- each. Palmer's Double Magnet Time marker (B 16) is available from Gordhandas Desai & Co, at around Rs, 50/- each. An excellent Chronometer to record time upto 1/5 of a second is obtainable from Jacquet (Cat. No. 76) for Rs. 612/- only.

Rubin's figures may be locally prepared by any artist.

Experiment 15. *Demonstration of Brightness Constancy.*

A large metal screen of neutral gray is obtainable from The Technical Corporation for Rs. 12/- only. The other cardboard screens may be locally made. A book of Hering's Grey Papers are obtainable from C. H. Stoelting & Co.

Experiment 16. *The Effect of Practice in Muller-Lyer Illusion.*

Muller-Lyer Illusion board as Stoelting's Cat. No. 27100 is obtainable from The Technical Corporation for Rs. 75/- . A satisfactory box type design with knob arrangement and a scale at the back has been prepared by the Aero Voice and is sold for Rs. 75/- only. Aero Voice has also prepared Muller-Lyer Illusion Card and sells it for Rs.8/- each. This card can be prepared in the laboratory according to the suggestion made by C. S. Myer's in his *An Introduction to Experimental Psychology* p. 55 (Cambridge Univ. Press, 1925).

Experiment 17. *The Span of Apprehension.*

A Disc Tachistoscope (Whipple model) as that shown in Fig. 13 is obtainable from Aero Voice for Rs. 95/- only. Other types of Tachistoscope are available from Psychological & Physiological Apparatus Mfg. Co., Lucknow and Purohit & Purohit Poona. Tachistoscope capable of holding 15 Cards at a time and in which the exposure intervals are controlled for 1/10 of a secd., 1/5 secd., 1/2 secd., 1 second, 10 seconds, & 30 seconds with the help of a self-driven rotating drum, is obtainable from The Technical Corporation for Rs. 475/- each. Aero Voice has prepared a handy camera shutter type Tachistoscope that can give time exposure up to 1/100 of a second and it is sold for Rs. 200/- only. Anand Agency sells a box type Camera Shutter Tachistoscope for Rs. 300/- . Tachistoscopes in which speed of exposure can be varied from 10 m. s. to 1000 m.s. in units of 10 m.s. which is required for studying 'recognition threshold' are obtainable from Stoelting & Co. and Western Electric Company, U. S. A.

Experiment 18. *Fluctuation of Attention.*

Masson's disc may be prepared locally by any artist according to the instruction given. Psychological & Physiological Mfg. Co. sells one for Rs. 5/- only. For other materials, see notes on Apparatus for Experiment No. 14.

Experiment 19. *The Effect of Noise.*

Procure a small drum and a hammer from any hardware shop.

Experiment 20. *Study of Habit Interference.*

A sheet of cardboard 22 × 22 inches and a pack of playing cards may be available from any local dealer. Purohit & Purohit has prepared one Card-Sorting Tray with adjustable compartments and sells it for Rs. 45/- each.

Experiment 21. *Study of Bilateral Transfer.*

Mirror drawing apparatus of wooden base

with hinged metal screen as Palmer's Cat. No. W. 350 is obtainable from the Technical Corporation Ltd., for Rs. 35/-. Aero Voice sells the Stoelting model (Cat. No. 31213) for Rs. 35/- with wooden (Teak) base. The same with cork-wood base on which Drawing pins can be easily tacked, is sold at around Rs. 40/-. Purohit & Purohit sells the Whipple model with wooden base for Rs. 45/- each. Star outlines should be mimieographed.

Experiment 22. *Transfer of Principle.*

The problems to be used are given in the Manual.

Experiment 23. *Learning and Retention of Paired Associates.*

Aero Voice has prepared a satisfactory and reasonably priced electrically driven Memory drum and sells it for Rs. 200/- only. Memory Drum of Stoelting & Co. (Cat. No. 21136) are most satisfactorily built and the price for each ranges from Rs. 450/- to Rs. 500/-.

Jastrow's Memory Apparatus can be used as a substitute. It may be obtained from Aero Voice for Rs. 75/- each.

In case, no memory apparatus is available the exposure device described in the text may be followed.

Experiment 23. *The Context factor in Recognition.*

Materials for this experiment are prepared in the laboratory and a Tachistoscope having an arrangement for long exposure time may be used. Otherwise the exposure device already described may be followed.

Experiment 25. *Retroactive Inhibition & Similarity*

See the notes for Experiment 23.

Experiment 26. *Social Transmission of Verbal & Visual Materials.*

Any short story will do. It is better, however, to use the story entitled "The war of the Ghosts', (cf. "*Remembering* by F. C. Bartlett, Cambridge University Press, 1932.).

Experiment 27. *Effect of Massed & Distributed Rest Pause.*

An inexpensive yet excellent Mosso Ergograph (B & T type) along with weights may be obtained from the Technical Corporation Ltd., for Rs. 225/- (Ep. 1006). Aero Voice, Anand Agency, Psychological and Physiological Apparatus Mfg. Co. also sell this apparatus. Palmer make self-recording Ergograph of Du-Bois type (Cat. No. W. 200) is available at around Rs. 500/-. Recording Drum prepared by The Technical Corporation (Ep – 125) can be conveniently set to horizontal position to work with the Ergograph.

Experiment 28. *The Disjunctive R. T.*

The most satisfactory Hipp Chronoscope is the one prepared by Jacquet (Cat. No. 85) which was available some years ago within Rs. 2000/-. Anand Agency has prepared an Electronic Chronoscope which reads time up to 10 m.s and the price is round about Rs. 1000/-. A highly precise Electronic Chronoscope can be had of Stoelting & Co, (Cat. No. 20247) for $ 510.

Pohl's commutator & Make and Break key may be obtainable from the Technical Corporation for Rs. 16/- and Rs. 28/- respectively. Aero Voice supplies a plug-key (Double-throw Switch) for Rs. 20/- only.

Dry Cell Batteries, flashlight bulbs, wires etc. may be purchased from a local electric shop.

Experiment 29. *Pneumographic Study of Emotion.*

The best foreign make Pneumograph is that of Jacquet (Cat. No. 42) and Harvard Apparatus Company. Gordhandas Desai sells Jacquet's make for Rs. 260/-. Aero Voice sells one Pneumograph for Rs. 45/- each. It is obtainable from Purohit & Purohit and Anand Agency for the same price.

Jacquet make Marey Recording Tambour (Cat. No. 104a) is available from Doctor & Co. at around Rs. 150/- each. Palmer make adjustable Recording Tambour (Cat. No. C–5) is supplied by Gordhandas Desai & Co for

Rs. 120/- each. The Technical Corporation has prepared a satisfactory Marey Tambour with horizontal lever movement and screw adjustment (Baird & Tatlock type) and sells it for Rs. 45/- only.

A Shock Apparatus may be available from Anand Agency. A toy pistol of good quality can be had of any big stationery shop. Rubber tubing and Quinine tablets are obtainable at any medical store. Extension arm for using long kymograph paper is available from The Technical Corporation for Rs. 150/- approximately (EP 130). Multiple Key (EP. 750) and Multiple time marker of Triple lever (EP.280) may also be obtainable from The Technical Corporation for Rs. 90/- and Rs. 70/- respectively.

For other materials, see notes on Experiment 14.

Experiment 30. *Knowledge of Results as an incentive.*

The Line drawing task is fully described in the text.

Name & Address of the Firms dealing in Psychological Apparatus

1. C H. Stoelting & Company, 424, North Homan Avenue, Chicago, Ill., U.S..A
2. Marietta Apparatus Company, Marietta, Ohio,. U. S. A.
3. Harvard Apparatus Company, Dover, Massachusetts, U. S. A.
4. C. F. Palmer (London) Ltd., Myographic Works, 63A, Effra Road, Brixton, London, S. W.2.
5. James Jacquet, Manufacturers of Precision Apparatus, Geneva, Switzerland.
6. Baird & Tatlock (London) Ltd., 14-15 Cress Street, Hatton Garden, London, E. C. 1.
7. The Technical Corporation (Private) Ltd., Sarojini Nagar, Lucknow, U. P., India.
8. Anand Agency, 844, Sadasiv, Poona-2, India.
9. Purohit & Purohit, 431 /43 Sukrawar Peth, Poona City, India.
10. Aero Voice, Bari Road, Patna-4, Bihar, India.
11. Bengal Chemical & Pharmaceutical Works, 94, Chittaranjan Avenue, Calcutta—12.
12. Adair Dutt & Co, 5 Dalhousie Square East, Stephen House, Calcutta-1
13. Biological Supply Company, Calcutta.
14. The ARTICO, 5 Dalhousie Square, Calcutta-1.
15. Psychological & Physiological Manufacturing Co., Rai Behari lal Road, Lucknow.
16. Gordhandas Desai & Co., 305, Hornby Road Bombay.
17. Doctor & Company, Bombay Mutual Terrace, 534, Sandhurst Road, Near Sandhurst Bridge, Bombay-7.
18. The Andhra Scientific Company (Private) Ltd., Mount Road, Madras.
19. The Chemicals Syndicate, Govind Mitra Road, Patna - 4

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